Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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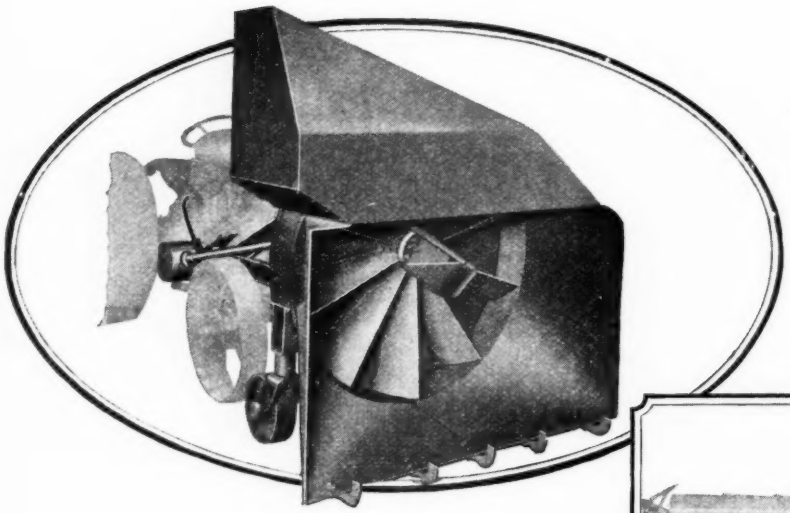

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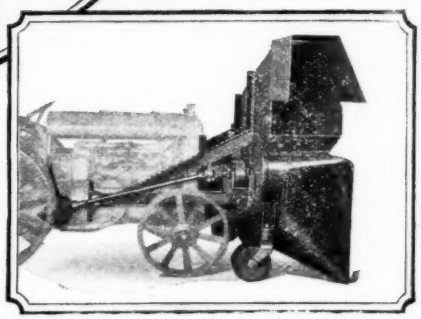

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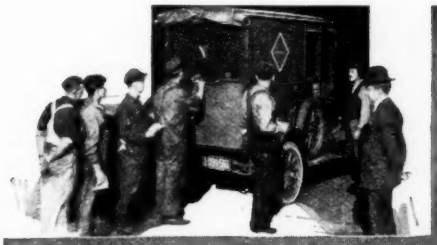

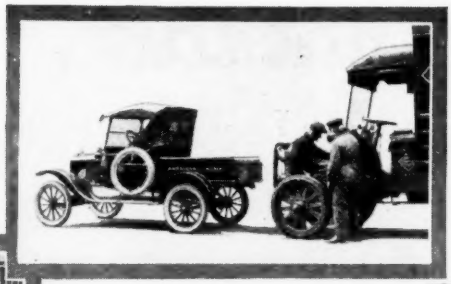

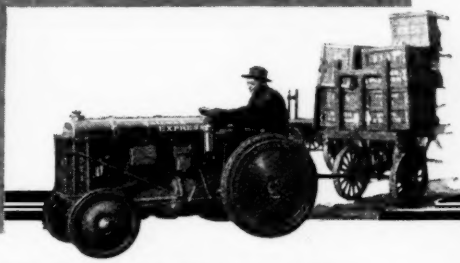

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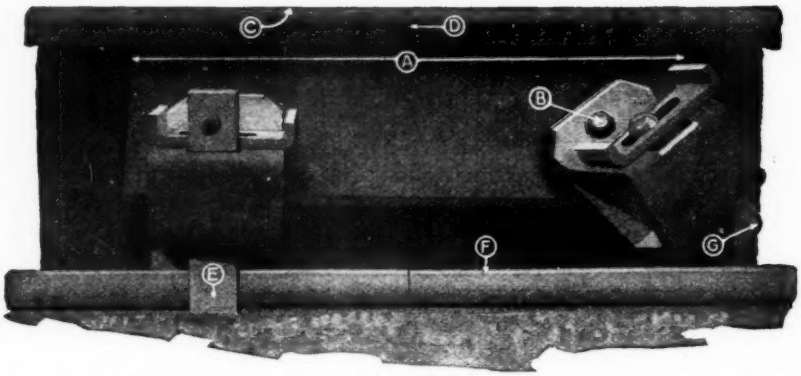

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C—Tread of rail free from obstructions.
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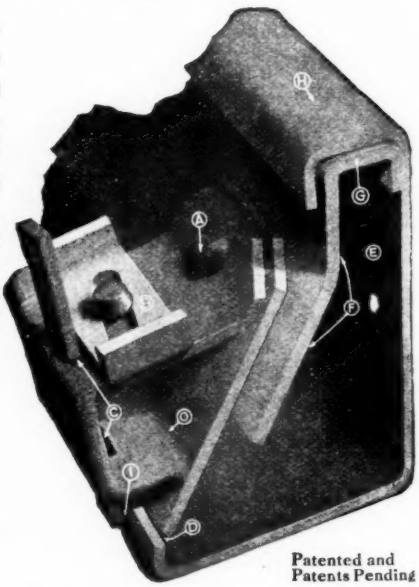
G—Tight joint reinforced with 1¼ inch flange. Head of joint forced up under tread.
H—Tread of rail 2⅛ inches wide.
I—Base of Form bears against steel stakes, absorbing thrust of subgrader.
O—Stake pocket welded to anchor lug.



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EDITORIAL

OUR LAGGING HIGHWAY DEVELOPMENT

At a time when road building is going forward more rapidly than ever before in the world's history it may seem strange to many to speak of highway development as lagging, but that it is lagging behind the development of the agency that called it into being, namely, the motor vehicle, can easily be shown. There is small danger that we will build modern highways too fast, but there is real danger that the present rate will not be sustained unless the people are made to realize that it is cheaper to have good roads than poor ones.

We believe that the average motorist, no matter how intelligent he may be or how successful in his line of business, thinks primarily of the good road as a contribution to his comfort and convenience; it enables him to come and go as he pleases and in comfort. He does not think of the financial aspects of the matter at all and there is where the danger lies. When he begins to feel the cost of modern roads, or to be impressed by the magnitude of present-day expenditures for road improvements, he is likely to sacrifice considerations of comfort and convenience in order to curtail the immediate outlay of money for these purposes. Unless he is made to see that money saved in road improvements is very expensive money to the road user he is almost certain, at no very distant date, to join those who are always ready to suggest that we are spending too much money on our roads and streets.

That we are not now spending anything like as much on rural highways, per motor vehicle in operation, as we did in the year 1904 is a matter of record. In 1904 there were, in the entire country barely 58,000 motor vehicles and these were nearly all passenger cars. In 1914 this figure had increased to 1,711,399; in 1919 it was 7,530,105 and in 1923 reached approximately 14,000,000 motor vehicles. Now compare the rural highway expenditures for the same years: 1904, $59,527,000; 1914, $240,264,000; 1919, $389,456,000; 1923, $800,000,000. Thus it will be seen that the rural highway expenditure per motor vehicle in operation in 1904 was $1,026; in 1914, $140; in 1919, $52, and in 1923, $57. This expenditure in 1923 was only 5 per cent of what it was in 1904.

The 14,000,000 motor vehicles in operation at the end of 1923 represented a purely voluntary investment by the American people of at least ten billion dollars. The cost of operating these vehicles in 1923, on the basis of an average mileage of 4,000 at 10 cts. per mile, was $5,600,000,000. Now if we can save just 1 ct. per vehicle, per mile, by improving our roads, and this can be done, we would save $560,000,000 each year, on the number of cars in use in 1923. Of course this saving will increase as the number of cars increases. Even this figure, capitalized at 4½ per cent would justify an investment of $12,500,000,000.

It is always good business to spend money to save it. The railways have often spent large sums of money to rectify line and grade, for example, in order to save on operating expenses. Every motor vehicle owner is in the transportation business; the business of transporting himself, if nothing else. He can be made to see that his annual investment in transportation will grow progressively less from year to year as the roads he uses are improved.

Probably the greatest difficulty in this matter lies not in getting the motorist to see the money-saving value of modern roads, but in getting him to turn over to public officials, in the form of taxes or fees, enough money from year to year to pay for these road improvements. Most people have some very peculiar ideas about the tax dollar. We spoke of the "purely voluntary investment of ten billion dollars." The people had all kinds of fun spending that money as they chose but they are ready to yell "murder" if they are taxed $10 to save them $100. Right there is where educational efforts must be applied to show not only that good roads save money but that they must be paid for and paid for out of taxes or fees of one sort or another.

Obvious as all this is to the worker in the highway field, it is anything but obvious to the general public, for there

are thousands of people clamoring for tax reduction and, in the same breath, for road improvements, without seeming to suspect that the roads they demand must be paid for and paid for out of the proceeds of road taxes and fees. This agitation for tax reduction, unintelligent as it often is, may be the cause of still further lagging behind in highway development, for while the citizen will undoubtedly go right on spending hundreds and thousands of dollars on his old car, and occasionally on a new one, he may balk at spending a few paltry dollars in the form of taxes for road improvement purposes if he is stampeded clear off his mental reservation by the age-old hokum about "tax reduction."

BUSINESS IN THIS PRESIDENTIAL YEAR

In 1924 we must, among other things, elect a President of the United States. Business in such a year is "supposed" to be bad, although there seems rather less pessimism this year than is customary. Perhaps this is due to the fact that so many have really been bumped in recent years that they find small satisfaction in gloomy forebodings. Then, again, it may be due to the fact that fundamental conditions are good and are improving so there is good reason to hope for a prosperous year. Whatever the cause of the present hopeful frame of the public mind, it is distinctly encouraging to find so much optimism at the beginning of a presidential year.

Perhaps presidential years are not so bad after all. What do the records show? Congressman Martin L. Davey of Ohio, recently characterized as "false and foolish" the generally accepted belief that a presidential year means poor business, in an article contributed to "The Nation's Business." He shows that when business was below normal in past presidential years, this condition was due to some fundamental economic cause, and not to the fact that a president was to be elected. He shows that since 1880 five presidential years may fairly be called fat and five lean. It is significant to note, also, that this fifty-fifty average was maintained in the latest presidential year, 1920, which had six months of good and six months of poor business. He makes the sensible prediction that "unless a majority of us get the popular notion that business is bound to be poor in a presidential year," 1924 should be a period of substantial, normal business conditions.

Another interesting fact that he brings out is that the difference between ordinary prosperity and ordinary depression is not over 10 or 15 per cent.

There seems ample reason to believe that this year will be one of substantial business prosperity and we hope that the construction industry will plan accordingly.

"EASY TO SAVE AND WORTH SAVING"

With the beginning of a new volume we again call attention to the practice of binding the volumes of this publication. The index to volume LXV is being prepared and will soon be ready for distribution. It will be sent free to any subscriber on request.

It is interesting to note that with every six months' period there is an increase in the number of requests for this volume index indicating, of course, an increase in the number of people who bind this magazine for preservation. The cost of binding six months, or even twelve, in one set of covers is comparatively small and the bulk is not great.

In going over the list of those who requested copies of the index six months ago we are much impressed with the sources of these requests. Engineers of all sorts have asked for a copy of the index, not only the large consulting engineers who maintain extensive libraries, but many engineers on a salary. There have been requests from manufacturers, from contractors, from engineering schools and colleges, public libraries and public officials in city, county and state, and practically every class of reader to whom the publication is addressed.

That the magazine possesses permanent value has often been demonstrated. Frequently requests are received for a copy issued some time in the past. Such requests have often been received for numbers issued as much as ten years ago. The most striking example, perhaps, that has come to our attention in recent years was an order received, not long ago, from a Japanese engineer for a 5 years' subscription and for a complete file of the publication from the time the first number came out in 1890 down to date.

PLANNING THE EVENTUAL ROAD

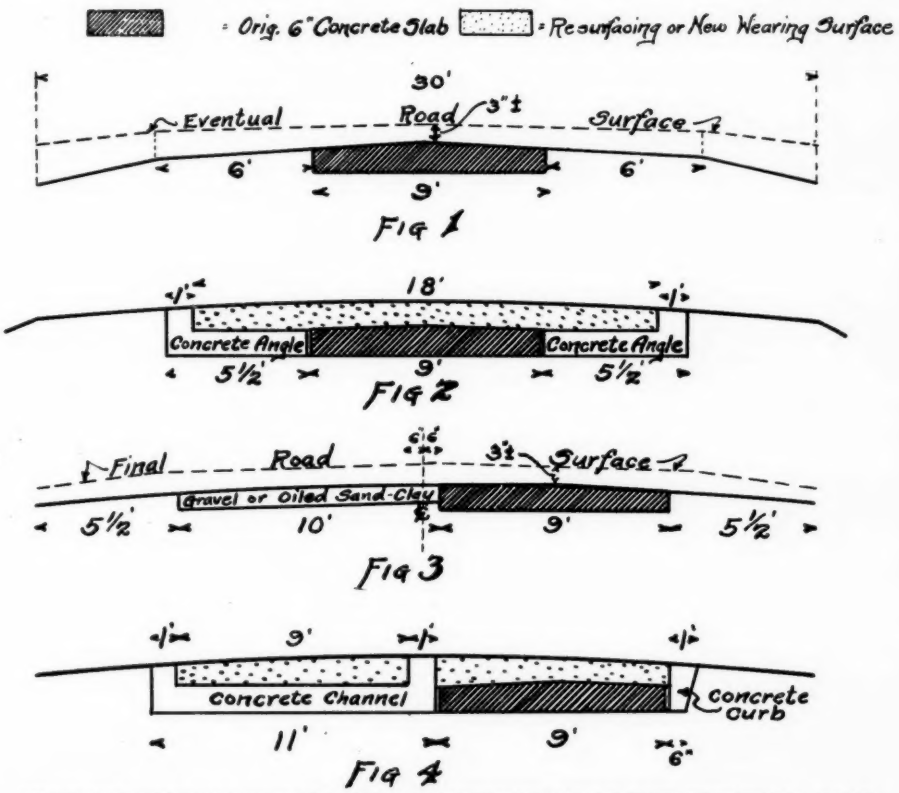
By Hugh J. Fixmer, Paving Engineer, Board of Local Improvements, 207 City Hall, Chicago, Illinois

The character and volume of traffic now using the through route highway approaches, and even exceeds, the traffic on the typical city street. It appears obvious that the type of pavement proved satisfactory for city streets might be successfully employed on heavy traveled roads. We have passed through an era of long experimentation in the design and construction of roads and pavements. We have learned many things. New designs must be based on the lessons learned from past failures, as well as the triumphs of successful experience. There are certain basic facts that the designer of road structures must observe. The road must accomodate the traffic. The effect of the paved surface on the user is as important as the effect of the traffic on the pavement.

The fundamental purpose of paving is to provide a smooth surface for the traffic. A pavement is judged by its surface. The pavement surface must prove safe and comfortable to use, must be efficient, economical and present a good appearance.

The pavement structure consists generally of three parts: The sub-base or natural foundation, the base or artificial foundation, and the wearing surface. The purpose of the base is to support and maintain the wearing surface and transmit all loads to the sub-base. The function of the wearing surface is to present a smooth, durable surface, resist wear, absorb impact and transmit pressure to the base. The base, together with the wearing surface, should absorb all impact or traffic shocks in order to avoid irregular deformation of the more or less yielding sub-base.

Materials of construction must be used to their best advantage if efficient and economical results are to be achieved. The sub-grade must be given serious consideration in connection with the choice of type of construction and the determining of the necessary thickness of the base. To secure uniformity, the thickness of the accepted base may be varied to compensate for poor sub-grade



SECTIONS SHOWING PROGRESSIVE CONSTRUCTION OF THE EVENTUAL ROAD.

or inadequate drainage. As a general rule, in order to withstand loads and impact a macadam base must be approximately twice the thickness of a good concrete base, which naturally eliminates its use in most places.

Constructed Joints vs. Irregular Cracks

Many of our new roads of monolithic construction are disfigured by longitudinal cracks. An irregularly formed crack is a source of weakness, shortens the life of the pavement, adds to maintenance cost and presents an ill appearance. In order to provide against longitudinal cracking, it can be shown, due to the effect of impact, moisture, temperature and frost action, that the safe thickness of a monolithic slab varies approximately as the width of the slab or road. The thickness at the center should be about one-twentieth of the width of the slab. The tendency to build roads wider entails an increase in thickness, and therefore cost, of monolithic slab roads, such as concrete or monolithic brick. The excess thickness is being avoided in recent practice by building a longitudinal joint.

Width of Roadway

The roadway on all important roads, due to the speed of vehicles and width of trucks, should be of permanent construction for a width of at least 20 ft., with durable shoulders at least 4 ft. in width, or temporary shoulders at least 6 ft. in width.

For minor or secondary roads, length is more important than width. All roads should be available for year-round traffic, at least for one line of traffic. Where funds are not available or the present need of traffic does not require the two line or standard traffic width, a single line width road should be built of permanent construction. Experience has proved the value of concrete, both as wearing surface for moderate traffic and as a base for heavier traffic.

Progressive Construction of the Eventual Road

In planning any road the "eventual" road should be predicted and the present road so designed as to be of service later in the final plan. The answer seems simple. Build a concrete road 9 ft. wide, 6 ins. thick, at an elevation of about 3 ins. below final or established grade. This road may be placed on the center line with temporary shoulder 6 ft. wide (Fig. 1) or may be placed to one side with a temporary graded surface for the other half of the roadway (Fig. 3). When funds are available and traffic requires a wider serviceable roadway, the single traffic road becomes incorporated as a base in the new roadway. This part may be surfaced with brick, reinforced concrete, asphaltic concrete or standard asphalt (Fig. 2). The shoulder curbs, being white, plainly mark the edge of the road at night. A middle curb to serve as a marker, may be built as shown in Fig. 4. When surfaced with concrete, curbs are not required, but a center longitudinal joint is advisable. In this way there is no appreciable loss, as the concrete has served "its time" as a wearing surface and is available as a base in the "eventual" construction. The grading done originally is practically permanent. The material secured from the cutting necessary in widening the roadway is used to raise and extend the new shoulder.

The idea of utilizing a concrete pavement, first as a temporary wearing surface and later as a base, or part of a base, was applied to city streets by the writer many years ago. In this case the curbs were built at the established grade and the pavement built 2½ ins. below normal grade to permit a surfacing of standard asphalt when the concrete surface outlived its usefulness. A 1:2:4 mix was used, which seems adequate in view of the provision for future surfacing.

This article is an appeal for the extension of this idea elsewhere and particularly in the field of road improvement where economy is paramount.

THE DOUBLE DECKED, SOUTH WATER STREET IMPROVEMENT IN CHICAGO

By Paul E. Green, Consulting Engineer, 400 N. Michigan Ave., Chicago, Ill.

The "loop" district in Chicago is one of the busiest and most congested city territories in the world. It consists of a rectangular area approximately seven blocks north and south by five blocks east and west. In this territory is concentrated the great department stores, banks and office buildings of the City of Chicago, and in effect this is the heart of the city. To the east is Lake Michigan and to the north, south and west are great industrial districts. Immediately north of the loop is the main channel of the Chicago River, a navigable stream

having a usable width of 200 ft., while on the west is the south branch of the river. The river divides the city into the north, south and west sides, each side having approximately 1,000,000 inhabitants.

From the south the method of entering and leaving the loop is practically confined to three streets and one boulevard, because nearly all of the rest of the territory is occupied by railroad yards and property. All the traffic from the north and west sides enter over bridges across the Chicago River and the south branch of the Chicago River. These bridges are used by passenger automobiles, street cars, auto trucks and in three cases by elevated railways. There are 16 such bridges, as well as three street railway tunnels. The traffic conditions in this central business district have become almost unbearable. It is estimated at this time that approximately 150,000 vehicles enter and leave the loop in a 12-hour day. Michigan Avenue to the east is confined to passenger automobiles, which now average 30,000 to 40,000 vehicles per 12-hour day and at times is used by as many as 75,000 automobiles.

Double-Decked Distributing Viaduct and Street

In order to relieve the intolerable traffic congestion and to provide for the free distribution of traffic between the various sides of the city, the city has planned a great marginal double decked distributing viaduct and street along the north and west sides of the central business district. This is called the South Water Street Improvement. It is an integral part of the Chicago Plan. It starts at the Michigan Avenue Boulevard Link Bridge Improvement, which has just been completed at a cost of $13,000,000, at River Street and Michigan Boulevard, with a double deck structure along the north branch of the river as far west as Randolph and Market Streets, on the south branch of the river and continues as a single roadway to Madison and Market Streets, a total distance of about one mile. It will replace the present South Water Street, which is the great produce market of Chicago. In addition, it occupies all the space extending from the present north line of South Water Street and River Street to the south bank of the river, making a structure 135 ft. wide.

Elements of the Project

The upper level consists of a reinforced concrete viaduct having a roadway of 72 ft., paved with asphalt, and two sidewalks, the south walk being 24 ft. and the north walk 18 ft. The elevation of this upper roadway is to be about 6 ft. above the level of the existing street and is to be connected to Lake Street, which parallels it to the south, at intersecting streets by approaches with a grade of about 2.6 per cent, and to the north with 10 of the 16 bridges mentioned. The lower level, which is set at an elevation of about 9 ft. below the present grade, will have a roadway paved with granite blocks of approximately 90 ft., dock wall and space on the north or river side occupying approximately 40 ft. and a combined ventilating duct and loading dock on the south side occupying a width of approximately 5 ft. It is planned to divert the heavy trucking traffic onto this lower level. Entrances are provided by widening the alleys from the south.

Cost

The total estimated cost of this improvement is about $22,000,000. This is divided between land which is to be condemned, approximately $14,000,000, and the structure which is to be constructed at approximately $8,000,000. It is to be financed under the Local Improvement Act of Illinois, which means primarily that the cost is to be assessed against the property benefited. The benefited district is about three miles long and one mile wide. The city will probably pay about 35 per cent of the cost as a public benefit.

Traffic

Extensive studies were made to determine the probable traffic which would use this structure. The result of such studies are of course speculative since there is no precedent to base them on. Taking into consideration, however, the industrial districts of the city, the manufacturing, transportation and general distribution of business, together with the increase in traffic which has taken place in the last few years because of the almost universal use of automobiles, an approximation can be made which will tend to show what the probable use of this great structure will be when it is completed and its possible future use when other great projects which are under contemplation in the City of Chicago have been constructed. In this manner it was estimated that the probable use of the upper level when con-

struction is completed would be from 10,000 to 20,000 passenger automobiles per day and that as many more vehicles would use the lower level. The theoretical capacity of the structure is about 100,000 vehicles on each level per day, but such a theoretical capacity does not take into account the interruption to traffic from the crossing of intersecting streets on the upper level. The lower level has no street crossings and in time might be used to its full theoretical capacity. The upper level will probably be governed by automatic traffic signals.

Benefits Expected

South Water Street at the present time is, as has been stated before, occupied by the great produce market of the city. Its use for that purpose has tended to congest the other streets of the loop to a very great degree and the removal of this market, which is inevitable upon the construction of this improvement, will tend to relieve congestion over the entire business district. Approximately 15,000 vehicles are required to serve this district per day, and because of the character of the business they have had even more of an effect on congestion than ordinary traffic. Much of the time the wagons and trucks are idle, backed up against a curb. It is estimated that the removal of this South Water Street market to other parts of the city will save the public millions of dollars per year because of more economic handling of the produce and less injury and spoiling of the produce. In addition, the sanitary condition of this part of the city will be immeasurably improved. It is also expected that in place of the many blocks of ramshackle, unsightly buildings which now occupy this street, there will in a reasonable time be constructed modern high-class office buildings and department stores, and that the river front, instead of being unsightly, will become one of the most attractive in the world.

One example of the benefit to the public at large is that resulting from the reduction of grades on the present north side bridges. These grades are now about 5 per cent. The new structure reduces them to 2.6 per cent. This change means a yearly saving to the public of more than $2,000,000. Other items of benefit bring the total estimated annual savings to the public from the construction of this improvement to over $5,000,000, which if capitalized at 5 per cent equals $100,000,000. It is evident, therefore, that the improvement, aside from its advertising and scenic value, will be a very profitable one for the city at large.

A STUDY OF HIGHWAY ACCIDENTS IN PENNSYLVANIA

By W. A. Van Duzer, Equipment and Transport Engineer, Pennsylvania Department of Highways, Harrisburgh, Pa.

Motor vehicle registrations in Pennsylvania increased from 58,221 automobiles and trucks in 1912 to 831,000 in 1922 and over 1,000,000 in 1923.

In the opinion of Dr. Batt of the State Health Department, it is not fair to assume that automobile accidents are on the increase in Pennsylvania. While the rate per hundred thousand of the population of Pennsylvania may show an increase, the rate per thousand of vehicles in operation in Pennsylvania shows a decrease. The proper method of figuring, Dr. Batt says, is to consider each automobile a hazard and then to compare the number of fatal accidents with the number of hazards. The rate of population in Pennsylvania has increased far less rapidly than the number of automobiles. In 1910, with 10,000 registrations for each thousand cars registered there were 1.9 deaths by automobile accidents and in 1922 there were 1.4.

Deaths from automobile accidents per year in Pennsylvania since 1906, and by months in 1923, are as follows:

BY YEAR		IN 1923	
1906	19	January	75
1907	36	February	50
1908	29	March	79
1909	78	April	106
1910	103	May	110
1911	142	June	128
1912	184	July	158
1913	216	August	175
1914	287	September	164
1915	466	October	177
1916	658		
1917	814		
1918	855		
1919	818		
1920	1,042		
1921	1,086		
1922	1,197		

It is shown that the majority of these accidents occur in sections of the state where the least traffic is encountered. In the vicinity of Philadelphia, where there is practically one-third of the population of the state, there are only about one-eighth of the accidents. This would indicate that the more traffic that is encountered, the more careful are the operators.

Of the 230 accidents that occurred in October, nine were at railroad crossings,

33 at road intersections, 29 at bridges or culverts, 104 on straight roads, 50 on light curves and 36 on sharp curves. Intoxicated drivers were responsible for 22. In cases of this kind the reports are turned over to the Automobile Registrar, who, after further investigation, revokes the operator's license.

Five pedestrians were killed who were walking with traffic—in other words, upon the same side of the road as the car was traveling which struck them. We believe an educational campaign should be inaugurated to educate the people to walk so that they face traffic, instead of moving with it. No case has come to our attention where pedestrians were killed while walking against traffic.

In the accidents mentioned, 288 cars were involved with 555 occupants, of whom 202 were injured and 18 killed. Twenty-two drivers of these cars were intoxicated. It is interesting to note that the majority of the accidents occurred upon Saturdays and Sundays. Our traffic census shows that a large proportion of the roads carry double the traffic on Saturdays and Sundays that they do other days of the week, so that the proportion, although the roads are congested on Sunday, is about the same.

Owing to the decrease in traffic during November, there were only 201 accidents upon the state highways during this month. Railroad crossings had five, road intersections 19, bridges and culverts 23, straight roads 35, light curves 27 and sharp curves 24. The proportion of intoxicated drivers was about the same, namely 19.

A detailed road accident report is filled out by the caretaker or foreman in charge of the section. We have the state divided into foremen's, or caretaker's, sections from three to five miles in length, and believe that more accurate information can be obtained from reports filed by men actually in charge of the road than otherwise.

A recapitulation sheet is compiled monthly from these reports.

A monthly accident survey of the state was determined upon with a view of correcting the conditions causing these accidents wherever possible by reductions in curvature, widening of the roads and the placing of guard rails.

The engineers follow these reports closely and if it is shown that the road is responsible for the accident, orders are issued immediately for the correction of the condition.

SUGGESTED IMPROVEMENTS IN CONSTRUCTION PROCEDURE TO REDUCE ROAD MAINTENANCE COSTS

By H. S. Perry, Assistant Chief Engineer of Maintenance, Ohio Department of Highways, State House, Columbus, Ohio.

The present article details some of the fine points in construction which are overlooked or only partly practiced, thereby causing unnecessarily heavy maintenance work and expense. The suggested improvements in construction procedure are as follows:

Waterbound and Penetration Macadam

1. Build the base wider than the top.
2. Do more harrowing before rolling.
3. Get a better riding base.
4. Do not expect the top to be any more perfect than the base.
5. Correct high and low spots after initial rolling.
6. Use coarse (2¼-3½-in.) stone in base and top.
7. Do not use a stone that will powder.
8. Use the hardest stone you can get for penetration.
9. Get the cross section *right before filling.*
10. Screen gradually with dry stone.
11. Use too little bitumen rather than too much.
12. Just key the stone before filling.
13. Give the road all the rolling it will take after filling.

Cement Concrete

1. Insist rigidly on a *clean* aggregate.
2. Watch density of aggregate closely, varying mortar to suit.
3. Develop a mortar strength commensurate with aggregate.
4. Develop strength generally by increasing thickness, not by varying richness of mortar.
5. Insist rigidly on a uniform low consistency.
6. Use a straight edge religiously.
7. Stay away from fine sand.
8. Use a finishing machine straight through, regardless of widening on curves.
9. Figure curve widening on inside, but build it on the outside.

10. Barricade the curing pavement against *everybody*.

11. Don't take the weather man's word for it; sprinkle.

The Cushion of a Brick Pavement

1. Never use fine sand.
2. Keep the silt content in sand under 5 per cent.
3. Use preferably granulated slag, slag sand, limestone screenings, cement sand, clean coarse sand, in the order named.
4. Roll carefully, using 5-ton tandem.

In general: *Use the best inspector obtainable.*

Discussion

Three-fourths of the surface maintenance of a macadam pavement is done on the outer 2 ft., due largely to lateral yielding, which will in a large measure be relieved by base widening. Edge ruts are likewise reduced.

One of the chief causes of a rough macadam surface is a lack of harrowing. Adequate use of a harrow, together with raking down high spots and filling low spots after initial rolling, will almost invariably assure a good riding surface. A contractor remarked to the writer recently that, after having been requested to watch his high and low spots, he had never in ten years found it necessary. After a review of the jobs he had built, it was agreed that the cause of his poor workmanship had been largely discovered. A contractor will generally excuse careless base course construction with his personal assurance that the top course will be perfect. None but an ignorant or conniving inspector will accept such an excuse. It costs very little more, and in the long run, less, for the contractor to be required to make each course right.

There is a too general use of small stone in macadam construction, due to the fact that it is easier to work and gives a smoother finish. Coarse stones, however, crush less, can be filled better, and are soon built up smooth under maintenance, since they take surface treatments much better.

The use of a soft stone should never be permitted in any macadam construction. Powdering on the surface prevents filling, either in waterbound or penetration construction. Stones that are soft will powder under traffic as well as under the roller, with the result that good surface maintenance is very difficult.

Many contractors tend to delay the securing of an accurate cross section until after filling has proceeded to such an extent that it is impossible to work the surface properly with a roller. The cross section must be perfected before filling, if any kind of a job is expected. Harrow, fill low spots and rake down highs, and do it during the process of initial keying. It is impossible to get a good job unless filling be done gradually, whether it be fine stone screenings on waterbound or coarse screenings on penetration work. There is a limit that the surface will take, just as there is a limit for bituminous materials. Penetration roads are sometimes ruined by the use of too much bitumen, causing fat spots that are for a long time hard to work out under maintenance. Maintenance can build up a road surface slightly underfilled with bitumen, and a better road will result.

In cement concrete construction coated aggregate is sometimes permitted when the quality is otherwise satisfactory, resulting in poor concrete. Occasionally a coated aggregate is not objectionable, as may be the case in washed crushed limestone, where the coating consists of limestone dust entirely.

Quite a step forward would be made in cement concrete construction if the varying density of the aggregate would be studied more carefully and the mortar varied to suit. Frequently hair cracks are due to this cause, a definite number of sacks being used per lineal foot on an entire job, where a variation of as much as one sack per cubic yard might be warranted, due to varying aggregate. It is the writer's notion that the secret of hair cracks is to be found more in this cause than in any other.

The quality of the aggregate, granted that it is considered usable, should largely determine the desirable mortar strength in any given case. Where a somewhat inferior aggregate is to be used, the mortar should be weakened in proportion and the thickness of the road slab increased, because the maximum strength can only be developed in this way. The perfect test sample should break uniformly through the aggregate and the mortar in proportion to the area of the broken cross section filled by each.

The bane of the motorist is a rough riding surface, due in concrete to a lack of uniformity in consistency. Because of the fact that tests show that this should be low, and since wet concrete flows on

grades, the answer is *low consistency*, religiously kept *uniform*. This, together with the constant use of a straight edge, should produce an easy riding surface. It is safe to presume that a contractor who is desirous of securing a good appearing surface can easily be made to give a good job from top to bottom.

The use of an approved finishing machine should be required on all work. In this connection, however, it is well to add that some pavements have been overworked with this device. This is especially true where a fine or silty sand is used as fine aggregate, since it is easily brought to the top, causing the surface to peel off. It is also true when a light aggregate is used. Hand-finishing naturally is not so apt to develop this trouble, but it does not usually give the desired finished surface.

Widening on curves, together with superelevation, has grown to be a necessary part of a design. It is the writer's idea that widening on curves is much overdone in some sections of the country. But that is beside the point, which is this: The concrete road should be constructed by the continuous use of the finishing machine, rather than to abandon it when reaching a curve to be widened. The normal cross section should be retained around the curve, raising it gradually on the outside and lowering it gradually on the inside until the maximum superelevation is secured. Let the widening be figured on the inside but constructed separately on the outside of the curve, after the forms have been removed. This will place a joint in the pavement, it is true; but it will be out where the pavement is least used, and it will do no further injury than to add slightly to the cost of maintenance. This method of curve construction will be appreciated by contractors, will aid in securing a better job and a less costly job.

Finally, close the road, keep it *closed* during curing, and remember that *it can only be cured once.*

The cushion of a brick pavement is the most neglected of all the items in brick construction. Most anything is permitted, and generally no test is made. Fine sands and dirty silty sands are generally preferred by contractors because they are easier to work; whereas none but very clean coarse sand should be used, if sand is to be permitted to be used as a cushion. Slag makes a wonderful cushion; fine limestone screenings are good; or cement sand, this last-named being expensive. Further, the cushion should be carefully shaped and rolled with a 5-ton roller so that it will be slightly low; then a little more cushion should be added and templated to final position. The roller should always be used. Many a job has the cushion worked up half way through the brick.

The general item regarding inspectors needs little comment. No road should be built without having as an inspector the best possible man that can be secured, one who knows his stuff and knows how to get results without trying to ruin a contractor.

SURFACING FALL CREEK BOULEVARD, INDIANAPOLIS, WITH KENTUCKY ROCK ASPHALT

The surfacing of Fall Creek Boulevard, in Indianapolis, early in 1923 is significant in that it has demonstrated that many old gravel roadways may be reconstructed successfully at an appreciable saving. Although this pavement has been in service less than one year it has shown no signs of distress under an extraordinary volume of traffic and under extreme wet weather conditions which could not have been better calculated to test this type of construction.

LOADING KENTUCKY ROCK ASPHALT FROM STOCK PILE TO FORD TRUCK WITH BARBER-GREENE LOADER.

This particular section of Fall Creek Boulevard skirts the edge of the main residence district of Indianapolis. It absorbs and distributes the greater per cent of the traffic from the arterial thoroughfares leading to the business district.

Undoubtedly it carries a much heavier traffic than any other segment of the boulevard system proper.

Former Construction Required Expensive Maintenance

Like the other boulevards, of the city, Fall Creek Boulevard was surfaced with gravel. Almost every year, it was necessary to add new metal, and every spring the roadway was scarified, re-shaped and oiled. This, however, would put the drive in satisfactory condition for only a few weeks and for the greater part of the year it was unpleasant to travel because of pot holes and other surface irregularities due to heavy traffic. At only one or two places, however, did the roadway break through the sub-grade.

Details of New Pavement

Late in the fall of 1922 the Board of Park Commissioners let a contract to the S. M. Timberlake Co. of Indianapolis, for the surfacing of some 17,000 sq. yds. of this boulevard, with Kentucky rock asphalt. This action was not taken, however, until after John L. Elliott, city engineer, and C. H. Underwood, city chemical engineer, had made a personal inspection and examination of older rock asphalt pavements in Kentucky. The plans and specifications, which were prepared under the direction of Mr. Elliott, called for scarifying the old gravel roadway to a depth of approximately 6 ins. and reshaping it. Where there was an insufficiency of old metal, new sandstone or gravel was required to be rolled in until the area was firm and up to the grade of the old pavement.

Over the entire surface was then spread 2 ins., compacted, of new limestone. Screenings were applied with shovels from piles at the side of the roadway until the voids between the stones were filled to within about ½ in. of the surface. The base was thoroughly wet down and rolled.

The Kentucky Rock Asphalt was applied cold to such a depth as would give a compacted thickness of 1½ ins. after rolling. No binder course or seal coat was called for.

Because of the lateness of the season the contractor did not start the work until 1923. During the winter months, he had the rock asphalt shipped to him from Bowling Green, Ky., and stored it in the open in his yards. The rock asphalt was shipped in open top coal cars and no difficulty was experienced in unloading it.

Equipment Used

Equipment used on this job was a 10-ton 3-wheel roller and scarifier, an 8-ton tandem roller, shovels and light trucks. After the old roadway had been scarified the heavy roller was used for shaping it. Most of the limestone course and all of the rock asphalt surface was rolled with the tandem. The rock asphalt was hauled from storage in Ford trucks with dump bodies and dumped directly on the prepared limestone base a few feet ahead of the crew spreading and raking the asphalt surface. To prevent uneven compression under the roller, all the rock asphalt was shovelled into place and was not raked or spread from the piles. As an aid to the rakers in getting the proper grade, wooden strips were laid parallel to the roadway at intervals of about every 8 or 10 ft. These strips were the same thickness required for the rock asphalt before compression.

After being rolled the pavement was immediately thrown open in sections.

Behavior of the Material

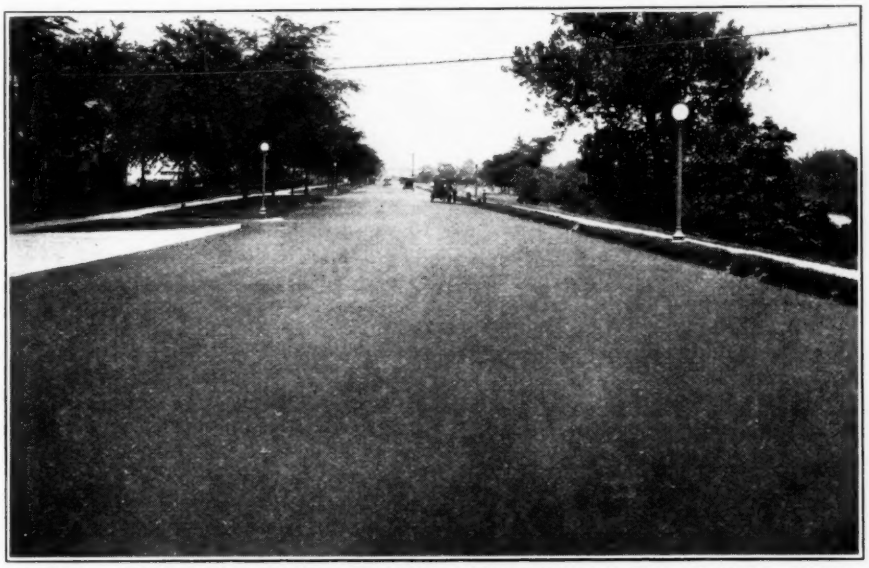
Aside from the fact that the Kentucky rock asphalt was laid cold there were several notable features in this construction. In the first place it was thoroughly demonstrated that the material was not susceptible to any damage from the weather. Not only was it shipped in open cars but it was stored in the open for several weeks before being used. Also, the rock asphalt did not harden under the pressure due to its own weight. The storage contained approximately 1,500 tons, yet the rock asphalt was readily loaded into the trucks with a Barber-Greene loader.

After rolling one section, about 100 ft. long, it was found that the base was uneven. The rock asphalt was taken up, the base corrected, and the surface relaid using the rock asphalt which had been removed. One or two small areas, which were low, were corrected by applying a feathered edge patch directly on the surface which had been rolled. The rock asphalt bonded so well with the surrounding surface that in a short time the patch could not be distinguished.

Performance of the New Pavement

When first opened the pavement was very black. After a very few weeks' traffic, however, it appeared like an ordinary sheet asphalt surface. It was notable

that roller marks and other slight irregularities in the pavement rapidly ironed out under the traffic. Those who have watched this pavement are unanimously of the opinion that it is smoother today than when first laid and that it is constantly ironing out smoother. Much comment also has been heard on the fact that the rock asphalt offers a non-skid. surface. This is due to the sharp angular grains of sand which compose the aggregate.



VIEW OF KENTUCKY ROCK ASPHALT SURFACING ON OLD GRAVEL ROADWAY ON FALL CREEK BLVD., INDIANAPOLIS, IND.

Because of the prominence of this boulevard and its central location the work was inspected almost daily by visiting engineers. In the very center of a region where gravel roads predominate, this construction has pointed the way to salvage thousands of miles of highway and convert them into pavements which will bear the brunt of modern traffic.

ROAD AND STREET SUBSOILS IN RESPECT TO PAVEMENT FOUNDATIONS AND WEARING SURFACE LAYERS

By J. W. Howard, Consulting and Testing Engineer of Roads and Pavements, 1 Broadway, New York, N. Y.

The U. S. Bureau of Public Roads has been making extensive investigations of subsoils and their treatment to support roads. Among the tests are those of the physical and chemical nature of the subsoils, their water absorption and retention, their supporting power, etc. The results of this research are being published as it proceeds, establishing definite bases for safe conclusions.

From observations and practice of road and pavement design and construction during the past 34 years in various cities in the United States and elsewhere, the writer has studied with interest and profit the published results of the subsoil studies by the Bureau of Roads, supplemented by French and German publications on subsoils, drainage and foundations of roads.

It seems that a short, although incomplete, summary of the research work on subsoils in relation to roads may now be made.

The three essentials for a good, economical road are good drainage of a subsoil under and adjacent to the road to protect it against water and frost; good foundation layer to bear the weight and shocks of traffic; good pavement wearing surface layer to protect the foundation against weather and abrasion of traffic.

Conclusions

Avoiding technical verbiage, the following conclusions as to subsoils seem warranted:

1. Subsoils of gravel or sand or com-

posed principally of these, from which water easily drains out, require little study as to drainage, except where adjacent land is so low as to carry water even temporarily to the subsoil under a road. In such cases the surface of the subsoil on which the pavement foundation rests must be well above the surrounding land, and drains must be so installed as to protect the subsoil under the road from water.

2. Subsoils of clay or other materials which hold water permanently or for long periods, must have special treatments, the principal ones being one or more of the following: (a) Elevate the surface of such subsoil on which the pavement is to be laid well above the surrounding country; (b) construct such longitudinal side drains and cross drains as are needed; (c) construct a road or pavement foundation of the kind least affected by absorbing moisture from below or otherwise, and the least affected by the freezing of any moisture getting into it; (d) construct one of the kinds of pavement wearing surface layers impervious to water and the least affected by water and frost.

3. The subsoil influences on the durability and inevitable subsequent maintenance of roads and pavements constitute a vital problem in the investment of more than one-half billion dollars annually by the States, not including the expenditures by counties and cities for roads and pavements; the bulk of which is borrowed money which should be invested in that which is permanent. The permanent portions of a road should and can be the proper permanent preparation of the subsoil and the construction of a permanent foundation thereon. Then the wearing surface layer can be one of the various available established standard materials, according to local conditions and necessity. This surface layer can then be maintained in continuous good order indefinitely by proper prompt attention from time to time, the expense of this maintenance being paid from current annual income, not bonds.

As the subsoil goes, so goes the road or pavement. If the subsoil settles, subsides, seeps or slides away, or swells from accumulating water, or heaves from freezing of water in it, so goes the road foundation, down or up, causing unevenness, cracking and increasing damage to the entire pavement; facilitating rapid wear and disintegration from traffic and making it necessary either to rebuild the entire road with proper treatment of the subsoil by drainage, etc., or the laying of an entire new pavement or foundation and wearing surface layer, where funds are not available or from other causes the subsoil can not be properly treated. This last state of affairs is a condition which is too prevalent throughout our states, counties and cities.

4. As to pavement foundations, the more rigid and unyielding a foundation is, the greater is the injury to it by cracking caused by distortion from settlement or rising of the subsoil. Conversely, the less rigid and more pliable or resilient the pavement foundation is, the less it is affected by distortion of the subsoil. The two general types of foundations or bases are the rigid Portland cement concrete base, and the resilient asphalt concrete base, sometimes called bituminous concrete base. These resilient bases or foundations are in two groups, one pre-mixed and laid hot, the other by what is known as the penetration or asphalt pouring method. Both, when properly constructed, result in a dense, waterproof, resilient, durable foundation. Both types of foundations or bases are used on the two general categories of subsoils mentioned above, gravelly, sandy, self-draining subsoils, andthe clayey, moisture-retaining subsoils. For the clayey subsoils, however, the bituminous foundations are most suitable. Local conditions of good or of poorly drained subsoils determine the kind of base needed, rigid or resilient. For many roads the rigid and the resilient types of bases can be safely placed in competition with each other and more economical results obtained than otherwise. Whatever type or kind of road or pavement is built, money properly spent in making subsoils permanent under roads is well spent.

METHODS AND COST OF SNOW REMOVAL

By Frank F. Rogers, State Highway Commissioner, Lansing, Mich.

The geographical location of any state, its population and the development of its road system, are factors that will primarily determine where snow removal must have serious consideration. Michigan lies almost entirely between the forty-second and forty-seventh parallels of latitude, the Keweenaw Peninsula be-

ing the only portion projecting beyond the forty-seventh parallel. For the most part, the Lower Peninsula of Michigan and the State of New York lie in almost the same latitude, viz., between the forty-second and the forty-fifth parallels. The extreme southeastern portion of New York exends farther south and New York City and Long Island lie entirely south of the forty-first parallel, while the entire Upper Peninsula of Michigan and a small section of the Lower Peninsula lie entirely north of the northern boundary of New York. The City of Alpena, Michigan, is just north of the forty-fifth parallel and the Straits of Mackinac are about in the forty-sixth parallel. Although I have not made a very careful study of the snow conditions in New York, I assume that the snowfall in New York is somewhat greater than that in Michigan, partly due to the influence of Lakes Erie and Ontario on the western boundary of New York and partly the Highlands of the Adirondacks in northeastern New York.

Snowfall in Michigan

A glance at the snowfall contour map of Michigan shows that Michigan varies greatly in its annual average snowfall, the range being from 30 ins. in the extreme southeastern portion to 120 ins. in the northwestern portion of the Upper Peninsula. In fact the average snowfall over a period of 33 years at Calumet, which is a short distance above the forty-seventh parallel is 141.7 ins. and the average snowfall at Jackson, Mich., approximate latitude 42-20, over a period of 23 years, is but 35 ins., and the record for Monroe and Lenawee counties in the southeastern portion is 30 ins. and less.

Where Complete Snow Removal Is Attempted

At present the only part of Michigan where complete snow removal is attempted is that portion including and lying south of Bay City, the Thumb of Michigan being excepted since it contains no large towns. This area embraces 36 counties with a total population of 2,963,208, which is 80 per cent of the entire population of Michigan. There are only seven cities in Lower Michigan, north of this area, with a population of 5,000 and upwards, Alpena being the largest with a population of 11,101, and the total population of these seven cities being but 60,981.

The part of Michigan where snow removal is most complete contains nearly all of the best agricultural lands, the most highly developed roads of the state and also 86 per cent of the state's valuation. By this statement I do not wish it understood that there are no excellent farm lands and roads in other parts of the state, including the Upper Peninsula, but these latter roads are quite largely roads connecting the various towns and do not embrace large systems of county and township roads that now serve the richer agricultural regions of Lower Michigan.

The Upper Peninsula of Michigan contains 29 per cent of the total area of the state and has only five cities with a population of 10,000 and upwards or a total city population of 64,156. In addition, we have Calumet, which is commonly spoken of as a city, but which in reality is not even an incorporated village, but rather a community of approximately 40,000 inhabitants, functioning under a township form of government. Dovetailed into this town are the villages of Laurium and Red Jacket, with a combined population of 7,088 which, taken together, are commonly spoken of as the city of Calumet, where the famous Calumet and Hecla mines are located.

While, as has already been said, up to date there has been no systematic attempt at snow removal above the Saginaw valley, there is a growing demand for snow removal in the immediate vicinities of most of the towns which have something like 10,000 or more population, as well as all the way between such towns when not located too far apart. That is one of the problems which the State Highway Department is confronted with and will have to work out, if possible, in a satisfactory manner in the very near future.

Michigan has a trunk line system, including Federal Aid roads, of about 6,500 miles, on which it is spending approximately $3,000,000 annually for maintenance, which does not include reconstruction.

Cost of Snow Removal

The cost of snow removal during the last four winters on such trunk line roads as the state has participated in is as follows:

	Total	State's Share	Counties' Share
1919-20	$105,724.30	$59,780.00	$45,944.30
1920-21	35,043.06	20,816.45	14,226.61
1921-22	83,202.38	52,257.63	30,944.75
1922-23	87,153.16	52,879.87	34,273.29

I should explain that in Michigan the counties are required to pay a certain percentage of the cost of trunk line maintenance, the state paying from 50 per cent to 90 per cent of the cost of this work. The law provides that counties having a valuation per trunk line mile of less than $50,000 shall pay only 10 per cent of the cost of trunk line maintenance, while counties having a valuation of upward of $500,000 per trunk line mile must pay 50 per cent of this cost, others ranging in between these extremes. The general average is about 40 per cent from the counties and 60 per cent from the state.

Mileage Costs

I have no mileage costs of maintenance except for the winter of 1922-1923. During that winter exact costs were kept on 3,615 miles, somewhat less than the total mileage in which the state participated during that period, at a total cost of $73,396, the average cost per mile being $20.30, while the depth of snow removal ranged from 6 ins. to 6 ft. Five hundred seventy-seven miles of this work was in the Upper Peninsula, the average cost of which was $66 a mile; the remainder being in the Lower Peninsula and practically all the area south of Bay City, at an average cost of less than $12 a mile.

Improved Machinery Reduces Costs

From the figures above given, covering a period of four years, it will be noted that the highest cost was during the winter of 1919-1920 at a little more than $105,000, which amounts to approximately 3½ per cent of the total cost of trunk line maintenance during the year. It will also be noted that the cost for 1920-1921 was only $35,043, or approximately 1-3 the cost for the winter of 1919-1920. This is due to the fact that Lower Michigan had but a very light snowfall that season. During the year 1921-1922 the cost rose to $83,202, and in 1922-1923 to $87,153, more than double the cost of the 1920-1921 season, but only about 80 per cent of the high record for 1919-1920. While this is mostly due to the fact that we had a much greater snowfall in 1919-1920 than in 1920-1921, no doubt some of the decreased cost is due to more experience in snow removal and in no small amount to the improved machinery for this purpose. At least a greater mileage has been removed each succeeding year, and men who are in closest touch with the work assert that much more is now accomplished for the money spent.

The subject of snow removal is now receiving a great deal of attention from the manufacturers of machinery adapted for this purpose, and there is a growing demand in all the states for roads that can be used 365 days in the year.

Michigan has upward of 700,000 licensed motor vehicles and approximately 14,000 miles of improved highways out of a total mileage of slightly more than 75,000.

A Classic of American Literature Recalled

Times have surely changed since Whittier as a boy received his inspiration for "Snowbound" on a typical New England farm of 100 years ago. His graphic description of the home life with the cheer around the big open fireplace, and later the fantastic figures wrought by the snow on the group of farm buildings which greeted his view when the storm had subsided—altogether make a rural winter scene of surpassing beauty and loveliness. Then came the process of breaking open the road:

"Next morn we wakened with the shout
Of merry voices high and clear;
And saw the teamsters drawing near
To break the drifted highways out.
Down the long hillside treading slow
We saw the half-buried oxen go,
Shaking the snow from heads uptost,
Their straining nostrils white with frost.
Before our door the struggling train
Drew up, an added team to gain.
The elders threshed their hands a-cold,
Passed, with the cider mug, their jokes
From lip to lip; the younger folks
Down the loose snow-banks, wrestling, rolled.
Then toiled again the cavalcade
O'er windy hill, through clogged ravine,
And woodland paths that wound between
Low drooping pine boughs, winter-weighed.
From every barn a team afoot,
At every house a new recruit.

* * * * * * *

So days went on; a week had passed
Since the great world was heard from last."

Snow Removal a Modern Necessity

But this is truly a different age and every one must travel by motor vehicle or stay at home, and no one willingly does that. Even the doctor who prac-

tices in the country no longer owns a horse and rig, and if he can not reach his patient over the roads with his automobile he will drive only so far as he can on the roads that are passable and then require the farmer to meet him with a horse and get him through the drifts in the best way possible, or else he must resort to the primitive method and wade through the snow on foot. In fact the changed conditions in our manner of living and modes of travel make it almost necessary that the public highways on which so many dollars have been expended be kept open for public travel at all times.

Economic Aspects

Just how much money the public is justified in spending for that purpose will have to be determined by the public itself, and really should not be greater than the use of such road is worth on a rental basis for the period during which snow removal is necessary. It is obvious that money spent for snow removal in January and February cannot be used for construction or the more permanent types of maintenance during July and August, and for this reason many people begrudge the money necessarily expended in snow removal.

However, there is still another angle to the economic side of this question. Road surfaces which are covered with snow four or five months in the year do not wear out much during that period. The average cost per mile for trunk line maintenance in Michigan is about $480, or an average of $40 per month, which is twice the total average cost per mile for snow removal during the winter of 1922-1923, which was $20.30.

Method of Snow Removal

If it were not for drifting snows, the removal of snow to a considerable depth would not be difficult nor very expensive with modern machinery. Officials with most experience in fighting snow begin to remove the snow almost as soon as it begins to fall, and except for drifting winds would have the roads clear in a very short time after it quits snowing.

Since the drifting snows are the most difficult to handle, the question of preventing drifts is a very important one.

Careful observation of conditions along the roadside where snow is piled up, will generally show causes. While it is impossible to regulate the direction and velocity of the winds, it is at all times possible to remove from the roadside many obstructions that cause drifts.

New Fencing to Stop Snow Drifting

Since the old-fashioned rail and board or picket fences have almost disappeared from the roadsides and the modern wire fences substituted, there is very little difficulty from this source. Where they still remain it would often pay to remove them whenever it is apparent that they are the cause of snow blockades. The cost of taking down old fences, plus the cost of new fences, could often all be charged to snow removal and a saving shown after two or three years.

Frequently a growth of weeds along the roadside, which is hardly noticeable except to the keen observer, becomes the cause of much drifting. Brush along the roadside is also a large source of snowdrifts. The remedy is obvious.

In the laying out of road grades, long shallow cuts should be avoided, because they are sure to drift full of snow and are very difficult to keep open.

Snow Fences

Snow fences similar to those used by the railroads are of great help and could be used along the highways a great deal more than they are now. Suitable planting of shrubbery and hedges at proper distances from the roadside will produce the same results. In this connection I desire to quote from a letter received from Paul Israelson, County Engineer of Dickinson county, in the Upper Peninsula of Michigan. He says:

"To get results, the conditions arising from the drifting of the snow must be carefully studied each year. We are compelled to build new snow fences every year. This county has built about two miles of movable, sectional snow fences this year.

"These sectional snow fences are placed about 100 ft. from the road. It is surprising the amount of snow that these fences will stop. We have also plowed parallel to the windward side wherever possible, thus stopping snow until snow trenches are filled. The railroads around this section have tried placing blocks of snow on their fence lines. I have noted good results from the use of this method. Another bad feature is that in new clearings along the road, especially to the windward side, where the other side has brush and windfalls, the road at this

point will always be drifted. To overcome this we have placed snow fences and cleared out windfalls and small brush to let snow drift through into the uncleared portions."

Machinery for Snow Removal

It is not my intention to recommend any particular machine for this purpose, but it is necessary to speak of the different types of machines that are successfully used in this work. In the days of horse drawn vehicles where a considerable depth of snow could not only be tolerated, but was desirable for sleighs, breaking the track by hand methods was about the only means employed in snow removal. In Michigan during those years a great many counties and townships used snow rollers of large diameter sometimes drawn by three or four teams, thus packing the snow to a depth of some two or three and even four feet at times. After the roadbed was once packed in this manner, the drifting snow would blow over the smooth surface and a very good winter road was thus produced. However, great difficulties were encountered during the spring break-up when the great depth of compacted snow became slush or ice and had to be removed from the roadway at great expense.

Snow Rolling Obsolete

Mr. Sleeper, County Engineer of Luce county, speaks of rolling snow as follows:

"The method of snow rolling as practiced in this section was originated by the lumbermen, where a snow road capable of handling a heavy traffic was needed. Of course they went us one better, sprinkling the road with water for the purpose of forming an ice surface. The rollers as first used are practically the same as in use nowadays, with the exception that the manufacturers are giving up the wooden roller for the ones built of steel."

Modern Machinery

As has already been intimated, snow rolling has now become obsolete and in fact was never any good except for horse drawn vehicles. For complete snow removal the machines necessarily used are graders, either horse-drawn or attached to trucks, thus pushing the snow off from the road surface.

During the last two or three years tractors have been used, mainly of the tracklaying type, very successfully for this purpose. Several companies are building snow plows similar to those used on the railroads, but attached to tractors for this purpose. In some cases they are pushed in front of the tractor and in other cases are a separate unit drawn by the tractor which forces its way through the snow drifts ahead of the plow.

Rotary snow plows have been invented for this use, and in some instances are said to have been quite satisfactory. It is generally conceded that where rotary plows are required, a separate power unit must be provided for driving the rotary, as the tractor or truck will require all the power it can develop to propel itself and push into the snow drifts.

In conclusion, I must say it would almost seem like bringing coals to Newcastle for a man from Michigan to come to New York and discuss the question of snow removal, for I have no doubt that most of the supervisors of maintenance in this state have had as much or more experience with snow removal than has the average maintenance man in Michigan.

The foregoing address by Mr. Rogers was delivered at the Annual Conference on Highway Engineering held at Cornell University, Ithaca, N. Y., Dec. 20, 1923.

DESIGNING BRICK PAVEMENT TO FIT LOCAL CONDITIONS AT MT. OLIVE, ILL.

By Willis D. P. Warren, of Holbrook, Warren & Van Praag, Civil Engineers, Millikin Bldg., Decatur, Ill.

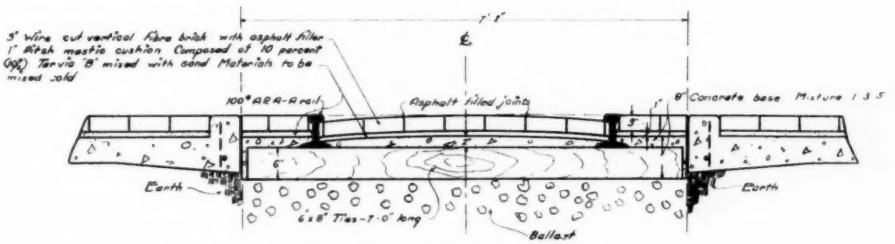
From time to time engineers who appreciate that pavements are subject to certain structural requirements, just as are other engineering structures, have discussed the significance of "local conditions" in the design of pavements. In this connection the writer desires to point out several features in the recent design of a brick pavement for the main business section of Mt. Olive, Illinois, a city having a population of 3,500, where the writer was forcefully impressed with the desirability and necessity of developing a special design which would effectively and economically meet certain local requirements. It is also desired to point out that in designing for special local conditions, we should properly consider not only those local conditions, but we should also endeavor to develop a design which will be "positive" in its na-

ture; that is, we should consider all the circumstances and conditions under which the proposed structure is to be built as well as used.

The Mt. Olive improvement required special consideration of several features, the most important of which will be briefly discussed, as follows:

Special Foundation Considerations

An investigation of the local conditions at Mt. Olive disclosed the fact that within the past two years a large sewer had been constructed along the center of the main street to be paved, and that many house connections had been made thereto since its installation. Although the main sewer trench was flooded with water from a city hose during construction, and the trench has been completely backfilled for a period of a year and a


3" Wire cut vertical fibre brick with asphalt filler
1" Pitch mastic cushion Composed of 10 percent (9%) Tarvia "B" mixed with sand Materials to be mixed cold
100# ARA-A rail
Asphalt filled joint
8" Concrete base Mixture 1:3:5
Earth
6 x 8" Ties - 7'-0" long
Ballast
Earth

DETAIL OF ELECTRIC RAILWAY PORTION OF NEW BRICK PAVEMENT AT MT. OLIVE, ILL.

half, it was deemed advisable to investigate the condition of the backfilling.

The investigation disclosed that the original sewer was laid to an average depth of about 15 ft., and ranged in size from 12 to 24 ins., thus requiring a trench at places approximately 48 ins. in width. Special test holes were dug in the old sewer trench under the direction of the writer, and an examination of the backfilling which had stood for a year and a half disclosed that great chunks of clay backfill at a depth of 5 ft. and 6 ft. in the trench never had been dissolved or substantially compacted. It is reasonable to believe that such a trench will continue to settle for quite a period of years.

In order to prevent settlement over this trench the pavement foundation was increased from an average thickness of 5 ins. to a thickness of 6 ins. for a width of 9 ft., sufficient to span properly the old trench and obtain a satisfactory support. In addition steel reinforcement was specified, comprising the spacing of $\frac{5}{8}$-in. bars varied in length and spacing according to the width of the old trench, the bars being 18 in. center to center and 9 ft. long over the widest portion of the trench.

In addition to the above precautions it is contemplated that special care shall be taken to flood the old sewer trench for a period of several days before constructing the pavement foundation.

Marginal Reinforcing Bars

Experience has demonstrated the value of longitudinal steel bars in the edges of concrete pavements for highways, and has also demonstrated the value of marginal and circumferential reinforcement, and for this reason it was considered desirable and economical to provide $\frac{3}{4}$-in. round painted steel bars in the concrete foundation, 6 in. from the edges. It is readily understood that the stresses in city pavements ordinarily 40 to 54 ft. in width, are not the same as those in a highway pavement, nevertheless local conditions may be such as to justify the use of such reinforcement.

The particular reasons for the use of such bars in the Mt. Olive pavement foundation are: General strengthening of pavement slab as a whole, the strengthening of foundation slab over numerous trenches where private connections have been made to sewer or water mains, and the strengthening of the foundation along the edges of the pavement where the sub-grade is ordinarily subjected to greatest variations in the amount of moisture and frost. When it is understood that it is most difficult to compact the subgrade adjoining the curb, that old trenches beyond the curb line (which is generally the outside line of the improvement) are subjected to a settlement extending under the pavement foundation, and that the use of such reinforcement will secure the positive results indicated above, it will be more fully appreciated

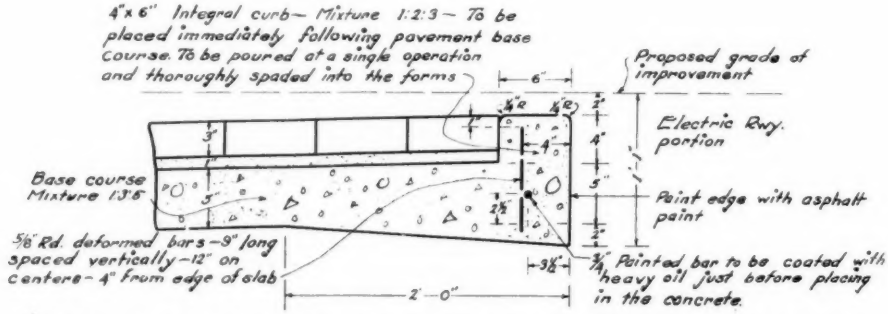
that a slight additional expense for this purpose is quite proper.

The concrete foundation specified for this particular project will be composed of a mixture of 1 part Portland cement, 3 parts sand and 5 parts broken stone or gravel, 5 ins. in thickness except as noted, and the materials shall be mixed for a full period of 60 seconds.

The sand cushion and 3-in. wire-cut vertical fibre brick with asphalt filled joints, offer no special or unusual features, but do contemplate a permanent and positive construction.

Curb

Consideration was given to using a one-course concrete curb, and to using a combined concrete curb and gutter. The use of a combined concrete curb and gutter will generally be advantageous, in that it tends to reduce the first cost.


4"x 6" Integral curb— Mixture 1:2:3 — To be placed immediately following pavement base course. To be poured at a single operation and thoroughly spaded into the forms
Proposed grade of improvement
6"
Electric Rwy. portion
Base course Mixture 1:3:6
Paint edge with asphalt paint
5/8" Rd. deformed bars—9" long spaced vertically—12" on centers—4" from edge of slab
Painted bar to be coated with heavy oil just before placing in the concrete
2'-0"

DETAIL OF PAVEMENT SECTION ABUTTING ELECTRIC RAILWAY SECTION, MT. OLIVE, ILL.

However, when it is considered that a pavement in the business section of a city will likely be subjected to ever increasing traffic, it is of more importance that it be so designed as to eliminate any unnecessary construction joints or possible sources of weakness. The construction of a combined curb and gutter establishes just such an objectionable weak construction joint, for a concrete gutter adjoining the brick portion of the pavement is separated from it by a continuous construction joint ordinarily without special protection, and furthermore, such a gutter is usually at a higher or lower elevation than the abutting edge of the pavementt. This condition greatly increases the opportunity for the early destruction of both.

Where a combined curb and gutter has been constructed, also, it has generally been the practice to use two-course concrete, resulting in a structure of decidedly uncertain character. It is quite well known that there are thousands of failures of two-course concrete curbs, due to lack of bond between the top and bottom courses.

A one-course concrete curb, 6 ins. by 18 ins., composed of a mixture of 1 part Portland cement, 2 parts sand and 3 parts broken stone or gravel, when poured in the forms at a single operation and carefully and thoroughly spaded, secures much more permanent and positive results. The form board for the exposed face of such a curb should be well oiled before placing the concrete, and the concrete must be thoroughly spaded in the forms, the top surface then being finished by the use of a simple hand tool. There should then be no occasion for any top coat, plastering or painting, and none is desirable or necessary. A one-course concrete curb constructed as above suggested, will present a neat and finished appearance, and, of additional importance, will be of a strength equal to that of other portions of the pavement.

Electric Railway

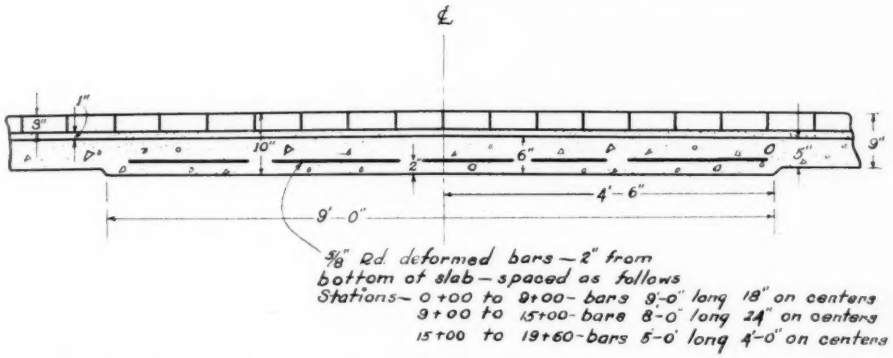
Pavements in street railways are expensive and difficult to keep in repair at best, and when it is further considered that by separating the city and railway portions of an improvement it is less difficult to fix the responsibility for any necessary repairs, it will be observed that there are a number of strong arguments favorable to the separation of the railway's from the city's portion of the improvement.

The railway portion of the pavement at Mt. Olive is accordingly so designed that it will be entirely separate from the city pavement proper, and will therefore be free to move vertically without producing

rupture in the city pavement. This method is considered quite essential if it is desired to maintain the city pavement in good condition adjoining the railway portion. A brief consideration of the forces acting on these two portions of the improvement will demonstrate that only a most expensive type of construction will resist the forces tending to rupture the pavement where the railway portion is constructed integral with the city portion.

Inspection of a recent job where the railway portion is constructed entirely separate, as is proposed at Mt. Olive, demonstrated that heavy, fast moving interurban cars cause substantial variations in the grade or elevation of the railway portion of the pavement only. In order, therefore, to insure free vertical movement of the railway pavement, proper portion of the integral curb section is considered necessary because of the narrow width of the particular street and the liability of heavy traffic along and on the curbing. In order to secure a positive bond between the upper and lower sections of this curb ⅝-in. deformed bars 9 ins. long, spaced 12 in. center to center, will be embedded in it.

The ¾-in. bars used as marginal reinforcement in the concrete foundation will further tend to strengthen this portion of the pavement along the railway. The entire cost of the proposed integral curb complete with ⅝-in. bars constructed integral with the foundation, will be less than a satisfactory curb constructed independent of the foundation slab, and the integral curb has the added advantage of strengthening the edge of the city portion of the pavement slab.


℄
1"
3"
10"
2"
6"
5"
9"
4'-6"
9'-0"
⅝" Rd. deformed bars — 2" from bottom of slab — spaced as follows
Stations — 0+00 to 9+00 - bars 9'-0" long 18" on centers
9+00 to 15+00 - bars 8'-0" long 24" on centers
15+00 to 19+60 - bars 5'-0" long 4'-0" on centers

DETAIL OF BAR SPACING ALONG CENTER OF 54-FT. BRICK PAVEMENT SECTION, MT. OLIVE, ILL.

vision has been made at Mt. Olive also for the painting with asphaltic paint of the edges of the abutting sections of pavement.

Integral Curb

In order further to separate the railway portion of the improvement from the city pavement proper, it was considered desirable to construct a curb along each side of the railway portion, and after some study it was determined that the cheapest and most effective curb, considering track repairs, etc., would be one constructed integral with the foundation of the brick pavement. This can be readily accomplished as the foundation is being laid by simply placing an additional form board after the foundation has been struck off, thus forming the curb integral with the foundation.

The use of a 1-2-3 concrete for the up-

Mastic Cushion

The use of a pitch mastic cushion under the brick on the railway portion of the pavement, instead of a plain sand cushion, is very desirable for the purpose of waterproofing the subgrade, and for the further purpose of preventing the shifting of the cushion.

Experience has shown that the concrete foundation under the brick in the railway section will soon crack under heavy loads, and in order to prevent shifting of the sand cushion and a resulting destruction of the waterproofing qualities of the asphalt filler in the brick, it is quite essential that a mastic cushion be used. A mastic cushion composed of 10 per cent Tarvia "B" mixed with sand and applied cold will not be expensive for this portion of the improvement, and

furthermore will afford several more permanent advantages than sand.

Conclusion

In conclusion it is desired to emphasize not only the significance of "local conditions," but also the desirability of "positive construction" when planning the design for any paving improvement.

"Local conditions" should include such features as bearing capacity of soils, street railway conditions, old street excavations, etc., and moreover should also include other surrounding circumstances and conditions such as the probable character of inspection service during construction, the probable maintenance service after construction, and the season of the year in which the improvement will likely be constructed.

When it is understood that few, if any, of the smaller cities undertake regular maintenance as practiced by our state and county highway departments, and when it is further recalled that city improvements are generally constructed under average, and not ideal conditions as to supervision, inspection and contractor's organization, it will be more fully appreciated that "local conditions" is a broad term.

By "positive construction" is meant construction such as results where a concrete curb is built of a one-course rich mixture throughout, the materials being poured at a single operation. The reverse result is quite generally to be expected where a two-course curb and gutter is constructed as above outlined.

Finally, it is desired to point out that in designing a paving improvement with special reference to local conditions, we must endeavor to secure a "rational design" and tto apply our knowledge of the well-known principles which govern the economical design and construction of such an improvement.

THE PAVING ACTIVITIES OF THE CENTRAL SOUTHWEST

By H. C. Smith, Manager Southwestern Branch, The Asphalt Association, 314 Dwight Bldg., Kansas City, Mo.

Rural Paving

That the construction of modern automobile roads and paved streets in this country is gaining in volume year by year is shown by statistics just announced by Highways Information Service, New York. The figures show also there is not a month of the year in which a large amount of construction is not placed under contract.

In 1920 a total of $530,848,000 in new road construction was awarded in this country. In 1921 the amount was $630,712,000, an increase of $99,864,000 over 1920. In 1922 contracts were awarded to the amount of $669,428,000, an increase of $38,716,000 over 1921 and $138,380,000 over 1920. From January 1 to June 1, 1923, a total of $384,774,000 was placed under contract. At this rate new highways for which contracts were let during 1923 will cost approximately $794,000,000, a gain of about $125,000,000 over 1922.

About $1,250,000,000 all told for Federal, state, county, district, township and city highway construction and maintenance were expended in 1923. The Federal and state appropriations for state highways alone total $800,000,000; the city and town appropriations for streets and roads total $285,000,000, and the remainder represents the funds to be expended by the counties, parishes, road districts and townships. It may help to grasp these figures when it is realized that compared with the 1923 road construction in the United States, the construction of the great Roman highways, the erection of the pyramids, the building of the Chinese wall and the excavation of the Panama canal pale into insignificance.

Highway work by states in the central southwest group of states through state and Federal aid actually under contract at present is as follows:

Arkansas	$ 625,000
Colorado	8,345,000
Missouri	29,233,000
Nebraska	1,218,000
Oklahoma	600,000

With the exception of the state of Missouri, which has designated its Primary and Secondary highway systems and launched its construction program under the $60,000,000 bond issue, it is seen that these five large and resourceful central southwestern states are contributing very little of the $800,000,000 of the Federal and state appropriations.

These figures should not be allowed to mislead one, however, as in other cases they represent only a very small part of the expenditures on rural highways.

These states are all actively engaged in highway building but, with the one exception previously noted, the major part of the work is being financed by appropriations other than Federal and state. A discussion of the highway financing of one or two of these states should make this point clear.

Arkansas Conditions

The Federal and state appropriations for Arkansas, listed at $625,000 for 1923, have not varied a great deal over the last few years. In 1920, however, the road building program of this state was approximately $100,000,000. Practically all of this work was financed under the assessment districts law. That this program was too extensive for the state was soon realized and a proper curtailment followed. There was not a complete breakdown in good roads sentiment or good road building, as is frequently elsewhere surmised. Although the state has not undertaken to finance its highway building as a state, which policy the writer believes would be a stabilizing and beneficial influence on its highway building, various subdivisions of the state are vigorously prosecuting their highway work with subdivision appropriations. One such subdivision is the county of Pulaski, which has recently announced a $3,300,000 project soon to be contracted.

Oklahoma Conditions

The state of Oklahoma, whose state and Federal appropriations for 1923 were only $600,000, had work on its highway system actually under contract during the year amounting to more than $10,000,000. Most of this work was contracted during the year. Here the work is financed largely by county bond issues, but the work is handled by the State Highway Department, of which W. C. Burnham is State Engineer. Although the difficulties in constructing a state system of highways under this method of financing are many compared to the advantages, it is encouraging to note that highway building in Oklahoma has enjoyed a gradual and continued growth since the State Department was established in 1915. This growth stands out as remarkable indeed when it is realized that it has been continuous in spite of state-wide unparalleled vicissitudes. There were two major disastrous floods during 1923 which cost the state millions of dollars; the slump in the oil business, which is one of Oklahoma's principal industries, gave the state a hard setback; and the state-wide calamity which terminated with the seating of M. E. Trapp as Governor gave the state so much unfavorable notoriety that there was an unwarranted demoralization of outside credit at a time when, due to adversity in the oil industry, this credit was most needed, causing an untold financial loss to the state. The security of the highway building industry in Oklahoma needs no better proof than the attitude of the citizenry, which forced the building to continue unabated in the face of these adversities.

Kansas Conditions

Kansas, not included in the previous tabulation, probably because it has not established a State Highway system, may be nearer the solution of its highway problem than any figures would indicate. Unfortunately for Kansas, it started its extensive highway paving program when it seemed to be popular to disregard all previous paving experience and lay an experimental and unproven type of pavement. Considerable of such was laid. The after effect of this was natural in that the sentiment throughout the state for paved roads appeared to be lukewarm, when as a matter of fact the sentiment has always been in favor of paved roads, but the decision as to control, which involves selection of type, as well as the decision as to method of financing, have been the stumbling blocks. Active organizations of road enthusiasts throughout the state, profiting by past experience, have crystallized a strong sentiment in favor of an economically sound and equitably financed highway paving program. In order that these two ideas may be allowed to form the basis of any future paving programs, perhaps the past delay will prove a saving in time.

City Paving

During the fiscal year from August 1, 1922, to August 1, 1923, authorized bonds for street improvement throughout the entire United States amounted to $101,421,275, which is an increase over the previous fiscal year of more than $4,000,000. This indicates that street construction for automobile and truck traffic is growing in extent and is keeping pace with the development of our rural highways. Even the small towns are extensively laying city types of pavement,

such as sheet asphalt and asphaltic concrete.

It is apparent by comparing the amounts appropriated from Federal and state sources in the central southwest group of states, as previously tabulated, with the total of $800,000,000 for the United States, that these states, Missouri excepted, are lagging far behind the rest of the country. A similar tabulation indicates the reverse is true in the case of bond issues for city pavement construction. Bond issues for city pavement construction in this group of states, authorized from August 1, 1922, to August 1, 1923, are as follows:

Arkansas	$ 1,301,715
Colorado	776,000
Kansas	2,645,086
Missouri	14,898,000
Nebraska	2,170,257

Reliable comparable figures for Oklahoma are not available.

Inasmuch as this large territory contains comparatively few large cities, the fact that the amount of city paving in these states is up to the average indicates that the small cities are sharing heavily in the paving program. A detailed analysis of paving figures shows that the small city activity is correspondingly great.

It should not be inferred that all city paving is new improvement. A great yardage of worn surfaces is being resurfaced. Omaha during the last two years has put an asphaltic concrete or a sheet asphalt wearing surface on more than eight miles of old brick pavements. Many many other cities throughout this group of states as well as some counties are salvaging pavements which, due to roughness or partial disintegration, have outlived their usefulness as pavements, but which serve as excellent bases for asphaltic surfaces which resist the wear and absorb the shock.

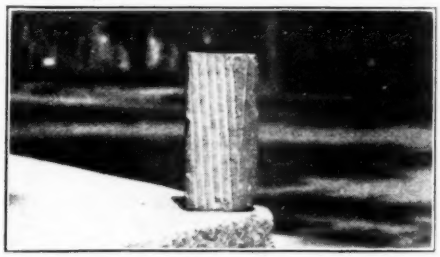
It is the feeling of the writer that the pavement industry throughout the states previously named has no need to anticipate a retrenchment of activities in city or rural pavements, but every one should prepare to take care of the demand that has followed and is still following the unprecedented traffic increase on the streets and roads.

PERFORMANCE OF BRICK PAVEMENT AT CLINTON, IOWA, DURING SERVICE OF 32 YEARS

By Charles P. Chase, Mem. Am. Soc. C. E., Iowa Engineering Co., Clinton, Iowa

The writer began his investigations on pavements 34 years ago in the Testing Laboratories of the State University of Iowa and was assigned a thesis on Brick Pavements. The subject involved the questions of best clays, manipulation, kind and size of brick, burning and manner of laying in the street. As a result of my year's investigation, supplemented by various inspection trips, a set of specifications for brick pavements was formulated which I first tried out at Clinton, Iowa, in 1891.

The essence of the specifications was a thoroughly "vitrified" brick, to be laid on a well drained base, with the earth and foundation of the exact shape of the finished pavement. Six to eight inches



VIEW OF PAVING BRICK REMOVED FROM CENTER OF PAVEMENT AFTER 32 YEARS' SERVICE AT CLINTON, IOWA.

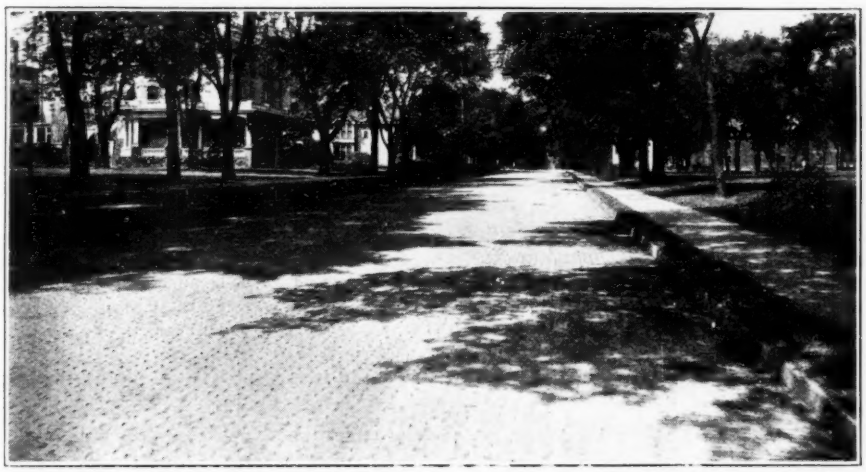
Brick is of original dimensions but is chipped on edges from wheels and horses, calks.

of sand-filled macadam rolled until hard, a 1-in. sand cushion, and then a square edged brick laid close and cracks filled with fine bank sand.

The one principle that I was inexorable on was that the brick must be thoroughly vitrified and practically impervious to water, and through all the years and experience with many makes of brick and tryouts of others' ideas I have never changed in this, and time has shown this to be absolutely correct.

My first brick job was Seventh Ave. from Second St. to Fifth St. in Clinton, Iowa, laid as above specified. The brick used were the small size (a little less than 2x4x8 ins.), Purington, Galesburg, Illinois, oil-burned brick. This is a main

residence street near the business center and formerly considerable lumber was hauled over it. The street stands today, after 32 years' use, almost perfect, with scarcely a sign of wear. Brick taken out measure the same as when laid and show the original kiln marks.



VIEW OF BRICK PAVEMENT ON 7TH AVENUE, CLINTON, IOWA, AFTER 32 YEARS' SERVICE

The only depressions in the pavement are a few places where it has been torn up and carelessly replaced. In all these years nothing has been spent for upkeep or repairs. If this pavement were on a suitable concrete base it would practically be indestructible from rubber-tired vehicles.

LOSS AND WASTE DUE TO FREQUENT CHANGES IN STATE HIGHWAY DEPARTMENT PERSONNEL

By H. G. Shirley, Chairman, State Road Commission, Richmond, Va.

(Editor's Note: The following is from an address by Mr. Shirley before the recent annual convention of the American Association of State Highway Officials. He suggests a remedy.)

In the last two years changes have been made in the directing personnel of 24 State Highway Departments. Due to this great number of changes taking place the question has arisen as to the loss and mistakes due to such changes.

It takes a man from one to two years to become familiar with the conditions and the highway system of the average state, and it is a great waste when we see at least 24 states changing their directing heads every two or three years. There is a reason for such frequent changes and it is the duty of this Association to direct its attention to finding the cause, and to show the public the great loss and other effects due to such frequent changes, and to suggest a cure for this condition of affairs.

Road administration, construction and maintenance has advanced by leaps and bounds in the past 20 years, and due to this rapid advancement the public does not realize its great importance. The progress has been so rapid that public sentiment has not been able to keep pace with it, and this, in my judgment, is partly the cause for so many changes. It is necessary for the highway engineers and administrative heads to keep abreast with this highway progress, and to direct and co-ordinate their work along such lines, but in doing so they often have to antagonize the leaders of the various parties or organizations who feel that the head of the department is going faster than the times justify and he soon becomes persona non grata, and a change is brought about. The highway official, not being expert in defending himself, easily falls victim to this sentiment, and I am sorry to say, in many instances, such action has a very large backing of public sentiment.

It is my opinion that the official mortality of our members that has taken place in the last three or four years is due greatly to the state of the public

mind. The unrest that was created and brought about during the trying period of the war greatly strained the nerves of the nation and it is the reaction of this great overstrain that has caused so many changes to take place, and the highway departments were no exception to this general shakeup.

It costs much money to train men thoroughly in the social, financial, climatic, topographical and seasonable conditions, as well as the characteristic types of soils and materials that go to make up the industrial natural resources of a state, and it is a great loss and a mistake to change such men too often when they have become familiar with all these local conditions.

At times such changes are brought about for political expediency. The greater number, however, have a deeper reason and often it is either the attitude of the engineer or commissioner, and his inability properly to interpret public sentiment so as to be able to control or govern it to gain public support to enable him to carry through his plans successfully. Often he allows his ideals to mistify and color his vision of what the public actually desires and demands, and he continues along the lines of accomplishing this ideal without giving heed to whether the public has been educated to it or not. It is just as dangerous to try and lead public thought faster than it can readily absorb and digest the plans and objects to which the highway official aspires, as it is to try arbitrarily to force the issue, regardless of how public opinion may consider such action or lend its support.

It is well to try and carry the work on just a little ahead of what the public would universally approve but not far enough to antagonize or obscure the vision of the public or to overshadow the ultimate object to be accomplished by hasty action. It should be the duty of the administrative head to take an inventory of each subdepartment, with a view of ascertaining exactly what public support it has and so change its operation as to bring it more in accord with the public will. I don't mean by this to cater to the political side of the issue in any way, for there is nothing more detrimental or dangerous to the proper functioning of a State Highway Department than to inject politics into its makeup, but to ascertain the opinion of the public as to the value of such subdepartment. It is absolutely essential that the department be conducted free of any political bias or influence, and that funds be distributed equitably. All employees must be employed on strictly a qualification basis, free of personal or political consideration.

During more than 20 years' experience in handling public works, the speaker is frank to say that, from the political standpoint, there has never been a time when this could not be handled without a great deal of friction, or without a great deal of effort along lines that would be for the best interest of the people at large. The politician is often abused for his methods and ways of handling public works, and his influence over public officials. It has been universally my experience that if an official shows that he has the best interest of the people at heart, and under no condition will he allow politics to enter into the operation of his department, then the best support he has received has been from those men who are generally classified as politicians; and in most instances, this support has been absolutely unselfish. Where the head of the department takes sides and shows that he favors a certain political issue or cause and is willing to use the influence and power of his position to advance the political welfare of some candidate or cause, then it is that the politician will use in every way possible the power and influence of the department to advance his political future. Do you blame him, under the circumstances? He will not, however, attempt this as long as the administrative head does not allow himself to be drawn into factional issues, or partisan politics.

When a department head has public support and the public believes that his efforts are in their behalf and will mean prosperity, comfort and wealth to the people at large, he will have no trouble whatever in securing this support to push forward any reasonable plan he may wish to carry out. It is the opinion of the writer that when this problem has been laid before the public in its proper light, the change, so frequently made in the immediate past, will cease; and men who have become experts and know their state's need will no longer be changed every two or three years, but will be retained in office so as to give the maximum amount of work at the least possible cost.

Yet, we know, that in many instances,

it is well to install some new blood into an old organization that has become stagnant and lost vision. It is necessary to bring new ideas and new ways and efforts into the department, and to do this it often is necessary to change its directing head.

I have tried to outline above the cause for these changes and now let us analyze their effect.

The effect cannot be but exceedingly detrimental when the directing head of a department has become narrow and the development of his mind has not kept pace with that of the needs of the system which he is developing. Under such conditions a change should be made. But, if the highway head is changed, due to personal dislike of a leader whom he has antagonized, because he was determined to carry out a program that he knew would be for the best interest of the state as a whole regardless of local or self interest, and because he insisted that the money paid in taxes be put in places and on roads where it would do the greatest good, then the change will be a great loss to the people, retarding the work and altogether disorganizing all other employees of the department and discouraging other able men from entering this line of work.

Men who are capable of directing and handling the expenditures made on our highways, running approximately into a billion dollars per year, should be of a type that will demand serious consideration before they are replaced with inexperienced executives. To handle this large expenditure in the very best way, there must be a stable term of office held out to such men, who are able and who have the honesty and integrity to see that the work is done properly and that this large annual expenditure is made in a way that it will bring to the people of the state and nation proper returns. Their term of office must be more permanent and they must be given assurance that, when they have spent a large number of years in this work, their services will not be dispensed with, requiring them, in many instances, to enter some other line of endeavor, and to give up practically a life's work, which they are eminently qualified and trained to carry on successfully.

The fact that the directing or executive heads of 24 State Highway Departments, in the past two years, have been changed without protest, shows that this Association has not taken sufficient interest in the welfare of its membership to make a serious protest or to try and bring before the public the great loss and mistake in making such changes. It is, therefore, my judgment that the fault is with the highway officials themselves, as they have not brought to the attention of the public the great need and importance of continuous services for such officers, in keeping with the officers of our railroads and other large organizations. When they have trained men for such positions they retain their services for long periods, to reap the benefit of the cost of such training and knowledge. Not until the public has been educated to the point where they will appreciate the services of their highway officials and realize when they have a good man, capable, in every way of carrying on the work successfully, that it will mean a great loss to dispense with his services and train a new man, will the continuity of services of such men be prolonged and in keeping with other large undertakings.

In conclusion, it is the opinion of the speaker that the trouble lies very heavily on the officials themselves, and that they must so prove their worth to the public that these changes will not take place, except for sufficient cause.

It is one of the duties of this Association to take up this phase of the question and to bring it before the public in such a way as will set forth just what it means to a state to be continually changing its highway department head. I feel that when this is clearly presented to the public, there will be a reaction against the past frequent changes, and will insure highway officials a more stable term of office, and their term of office will be in keeping with the service rendered.

INCREASED USE OF EXPANSION JOINTS IN CONCRETE PAVING

By C. V. R. Fullenwider, M. Am. Soc. C. E., Manager, Elastite Dept., The Philip Carey Co., 40 Wayne Ave., Cincinnati, Ohio.

In reviewing highway construction for the 1923 season a very noticeable feature is the decided increase in the use of bituminous expansion joints. A season or two ago state after state was abandoning them and building roads without expansion provisions. Dependence was placed solely in the ability of the con-

crete to withstand compression and to absorb the forces of expansion.

That this method has in general not proved entirely successful is plainly indicated. Omitting from consideration those states whose highway programs and activities are negligible, we note that while in 1922 there were about ten states using no expansion joints, this number decreased 50 per cent in 1923. Furthermore, a number of states that had previously been making use of only a limited amount of expansion joint, greatly increased their use of this material in 1923.

West Virginia and Minnesota, if information at hand is correct, used expansion joints in 1923 for the first time. After omitting them for several years, California used some this past season. Michigan, where heretofore joints were put in only in cold weather, is now using them at regular intervals throughout the season. New York, in 1923, placed ½-in. joints at 40-ft. intervals instead of ⅜-in. every 100 ft. as in preceeding years. Delaware, another state with jointless roads, is now reported to be specifying joints. It is learned also that in Missouri, where the Illinois practice using only a center contraction joint has been closely followed, at least one division has some recently completed road with bituminous transverse joints.

The writer understands that several other state highway departments contemplate revision of present specifications to include more liberal use of expansion joints in 1924.

It is a significant fact that although the total yardage of concrete paving laid in 1923 does not exceed that of 1922, yet from figures at the disposal of the writer it is apparent that the use of bituminous expansion joint has increased more than 25 per cent in the same period.

THE TENDENCY OF RECENT LEGISLATION IN REGARD TO FINANCING HIGHWAY CONSTRUCTION AND MAINTENANCE

By J. N. Mackall, Chairman and Chief Engineer, Maryland State Roads Commission, Garrett Bldg., Baltimore, Md.

(Editor's Note: The following is from an address by Mr. Mackall before the recent annual convention of the American Association of State Highway Officials.)

The tendency of recent legislation in regard to financing highway construction and maintenance is to charge to the motor vehicle user, through the tax on fuels, a larger and larger part of the cost of the road program in the various states. The speaker will point out what seems to him the greatest danger from this tendency.

A reference to the conclusions of the most able and convincing paper by Mr. MacDonald on the "Basic Principles of Highway Management and Finance," presented before the Virginia Good Roads Association at Roanoke, Va., in the winter of 1923, seems very helpful. They are:

"(a) States in the initial state of highway development should issue bonds to defer that portion of the annual charge for construction which would overburden either property or the road user.

"(b) States where original construction programs are well under way can, in the main, finance further expenditures for construction by bond issues devoted to deferring the cost of special projects.

"(c) States where original construction is practically completed are concerned chiefly with maintenance and reconstruction, and should depend on current funds, save in cases of emergency.

"(d) The maintenance of interstate and state roads should be a charge against the road user.

"(e) Roads serving a purely local purpose will generally require only light upkeep, and this should properly be a charge against the adjacent property, which in this case is the first and often the only beneficiary.

"(f) No road should ever be improved to an extent in excess of its earning capacity. The return to the public in the form of economic transportation is the sole measure of the worth of such improvements."

A series of conferences held between representatives of the Investment Bankers' Association, the National Automobile Chamber of Commerce, the American Association of State Highway Officials and the Bureau of Public Roads resulted in their agreeing upon these same principles.

Perhaps these principles can be subscribed to by every person interested in road construction and maintenance, whether they live in the city of a million people, or in the remotest part of the rural section in this country. One subject on which every one agrees is that better roads should and must be provided

for the transportation of products and of persons at all seasons of the year.

Paragraph "e," however, classes states which, in the opinion of the speaker, will not be reached for many, many years to come, for it seems that the construction of more roads simply demonstrates the need for still more roads. However, we all must realize that the time must come when the state cannot longer continue road construction as a unit. Certainly when Class "e" is reached, road construction must cease. Roads which will benefit only the adjacent property are roads which cannot reasonably be improved, certainly, unless we devise some very materially cheaper way of building and maintaining roads than has yet been devised in any municipality in the country.

This Association, when it met at Kansas City in 1922, adopted resolutions referring to the public protest against increase in real and personal property taxation, and urged upon all the states the readjustment of taxation for highway purposes as between real property and motor vehicles. The Association, it will be remembered, rejected as unjust and inequitable the principle sought to be established by certain automobile manufacturers, that the total cost of maintenance is the true mark of the total taxation to be imposed upon motor vehicles, and urged that a fair price for the road service given and a fair share of the total cost of the highways are the only proper measure of the contribution which should be made by the motor vehicle. The Association further suggested that the proportion to be paid by the motor vehicle should never be less than one-third of the total cost of the highway programs of all units of government.

The Association further went on record as approving the gasoline tax as the fairest taxation to represent road use and benefits received from such use. It urged upon all states the imposition of a gasoline tax of not less than 2 cts. per gallon as a portion of the imposts upon motor vehicles.

The trend of highway financing has certainly been in accordance with the recommendation of the Association of State Highway Officials at its last convention. However, when we pause to consider the great extent to which the user of the motor vehicle is being called upon to pay the cost of construction of roads, in some cases on the pay-as-you-go plan and in other cases on the bond issue plan, it causes the speaker to wonder if the placing of the burden upon the road user is not going to, in a very short time, be far in excess of the one-third recommended by this Association at its last convention.

The tax upon motor fuel is one which is easily collected and willingly paid. Any tax which is paid from day to day is relatively a popular tax. Any tax which is paid at the end of the year is a relatively unpopular tax. Let us hope, then, that simply because the tax on motor fuel is one which the motorist is willing to pay, that we are not going to saddle on him so great a burden that he will in the end refuse to pay. The fact is that up until 1919 taxation upon motor fuel had not been employed in the United States, and by the middle of 1923 37 States had adopted a tax on gasoline running from 1 ct. to a maximum of 4 cts. per gallon. That the automobilist had recommended and does favor this as the fairest method of taxation is not overstating the proposition. That the National Automobile Chamber of Commerce has endorsed this is going too far, but to say that they will endorse it is not going too far, and the speaker desires to predict solely upon his own responsibility that the National Automobile Chamber of Commerce will approve it in the very near future.

The speaker wonders how many persons realize the enormous cost of road maintenance on a large system of roads in comparison with the cost of construction, even in the state which has pushed forward construction at a most rapid rate. Mr. MacDonald set forth in his very able paper already referred to, "Basic Principles of Highway Management and Finance," that the duty of the states in which the main lines were not already complete was to carry forward construction as rapidly as physical resources would permit; that if current receipts did not provide sufficient funds for this purpose, then the deferred payment plan was the only solution. That the deferring of the construction of roads until they could be constructed from current receipts was not to be thought of and was not to be countenanced.

It would seem that every one who has made a study of the subject will agree with this as the correct principle, and that ability to secure labor and material should be the only measure of the speed of road construction on our main arteries.

The alarming thing about the recent

tendency in the financing of highway construction and maintenance is the extent to which automobile license fees and the gasoline tax receipts are being used to finance relatively long term bonds for construction. If the excess of receipts from the motor vehicle user over the maintenance cost were used annually for construction, certainly it could not be criticised by any man. To do this is the best of business, but to issue bonds running over a long term of years, and set up as the first call on the receipts from the motor vehicle user sufficient to pay interest and amortization on these bonds is insuring that the proceeds from the current receipts from the motor vehicle user cannot be used for road maintenance as the need for road maintenance and reconstruction continues.

Many roads; in fact, most of the paved roads today are being built of concrete. The cost of maintenance of these concrete roads is a relatively small amount and will remain so for a number of years, but who will say that bonds running for terms of even 15 to 25 years will be retired before the best of concrete roads will require extensive reconstruction and maintenance. It is the speaker's belief that one of the greatest calamities which could befall the transportation program of any state in the Union is to find that there were not sufficient funds from current receipts to maintain in perfect condition roads previously built from bond issues or from current receipts.

The speaker believes that it is fundamental that all maintenance and reconstruction be cared for from current receipts, and he believes that it is equally as fundamental that no prior charges be made against the prospective current receipts which could in any way prevent these current receipts from coming in sufficient volume to pay the maintenance charges on all the improved roads in the state. The speaker has heard representatives of the automobile industry argue time and time again for the issuance of long term bonds for road construction, and at the same time admit that the responsibility for the maintenance of these roads was and should rightly be the responsibility of the user, but the speaker believes that the greatest difficulty in this arrangement is the practicability of financing such a plan. If any community cannot raise with reasonably short term bonds sufficient money for the original construction of its roads, that same community cannot in 10, 15 or 20 years become sufficiently prosperous to pay for the reconstruction of these roads from current receipts. If reasonably short term bonds, say on the serial annuity plan, fully matured in 15 years, cannot be financed by a community from its general taxes, how is this same community going to, in 15 years, pay interest and amortization and *in addition* an annual maintenance cost much greater than this? Yet the automobilist has admitted and the automobilist does admit that it is his sole responsibility to pay for the maintenance and reconstruction of roads, and the speaker believes that he can with considerable propriety argue that this is the full measure of his responsibility.

If we take the principle adopted by this Association at the Kansas City convention, that the responsibility of the motorist should in no case be less than one-third of the total cost of the highway programs for all sources, we are almost admitting that the maintenance of a reasonably adequate state highway system is the full measure of the financial responsibility of the motorist.

The speaker will be pardoned for referring at this time to the little State of Maryland, but the point can be best illustrated from his point of view by citing the experience in Maryland for the last 15 years. The road construction program in Maryland has gone forward since 1908 at the rate of about two million dollars per year. All construction has been from bond issues on the serial annuity plan, full matured in 15 years, interest and amortization paid from the general taxes of the State. Its first issue of bonds in 1908 will be fully retired in 1923, so that construction by bond issue may continue at the rate it has in the past without increasing the total taxes for roads, and owing to the enormous increase of the taxable basis of the State, due to the increase in wealth, which can be traced directly to these same roads, with a substantial decrease in the tax rate. Taking into account our financial resources, this is considered fair progress. It has in the 15 years in which the principle has been in operation constructed and surfaced 17 per cent of Maryland's total road mileage, and it has today placed under the jurisdiction and control of the State Highway Department 2,300 miles out of a total of 15,000 miles. Its maintenance and reconstruction budget for 1924 is $2,400,000; for 1925, $3,000,000, and in

1927 we estimate and expect the legislature to provide a budget in excess of $4,000,000.

It is true that Maryland has constructed roads relatively thin and relatively narrow, and that the reconstruction now necessary in many places is caused by the necessity for the widening of these roads, but it does show most forcefully that if Maryland had tied up its funds from the receipts of motor vehicles for the interest and amortization of its $30,000,000 of construction bonds, that it would today have been in the position of having to finance its maintenance other than from the receipts from motor vehicles.

In 1925 it is estimated that the absolute minimum of maintenance and reconstruction requirements will be 50 per cent greater than has ever been the requirements for construction, and that by 1927 its maintenance requirements will be twice as great as its program of construction. Maryland today has a registration fee of 32c per horse power and a motor vehicle fuel tax of 2c per gallon, which is equivalent as revenue producing agencies to a registration fee of 60c. Its rate is about as high as any state in the Union, its ratio of automobiles to area or to road mileage is far above the average of the states, yet it takes all of these funds for the maintenance of its roads, and it is a most fortunate thing that its construction bonds were paid from the general taxes of the State.

The speaker believes that it is the urgent duty of the American Association of State Highway Officials to see that construction and maintenance funds are provided in a fundamentally correct manner, if the road program of the United States is to go forward with any regularity. Mr. MacDonald has conclusively demonstrated that road construction for main arteries should go forward as fast as labor or materials permit. It is agreed by all that a road once constructed from any source should thereafter be maintained from current receipts.

If, then, we consider the great part which improved roads play in the business of the nation; if we consider that good roads make cheap transportation, cheap transportation makes products go cheaply from the city to the farm, makes products of the farm go cheaply to the city; that they make for health, for wealth, for recreation and for education for a large part, then are we not justified in saying that the construction of roads is a benefit to every man, every woman and every child, regardless of where they live, and they should pay their share of the burden as a matter of right? If we say, on the other hand, that the wear and tear is a liability against the user and that all maintenance and reconstruction funds should come from current receipts and specifically from the instrument which causes the wear and tear, are we not safe in saying that the motor vehicle user should pay the cost of this maintenance, and should we not go further and say to the people of this country that we cannot reduce taxation on real property and at the same time build roads which will be of immeasurable benefit to this same real property?

Should we not say to them that roads are justified because they are needed, and they are needed because they make for wealth and happiness, and against poverty and unhappiness; because they bring the city to the country and the country to the city; because, in short, they add to the joy of living everywhere and that they must go forward as a matter of right? Then, if we say that if the general public will provide sufficient funds for the construction of roads, that the user shall pay for the cost of wear and tear on these roads, there will be ample funds for construction and ample funds for maintenance for all time to come.

Suppose for the sake of argument we say that the real property may eventually be owned by the families and that each family will own a part of it, and that the automobiles will be owned by the families and that each will own at least one; then it would not make a material difference whether funds for construction or for maintenance came from the general or from special taxes. With the growing tendency for families to own the real property which they use and occupy, and the much greater and greater distribution and use of the automobile, we may reach the point where, in the final analysis, the people would generally pay taxes on real property and motor vehicle taxes in about the same proportion. Suppose we do, still we cannot escape these facts, and we cannot say they are not fundamentally sound:

If the building of roads increases the value of real property, then the real property is the true beneficiary of the construction of these roads, and it should pay for the cost of their construction. If

the wear and tear is caused by the user of the road, the user should pay for the restoration, in order that the benefit which the real property has derived from the construction of the road shall not be taken away from it by the motor vehicle which uses the road. If we say this, if we demonstrate the wisdom of this, if in short, we "sell" this to the public, the future of transportation by motor vehicle is assured, and the problem most vital to all people for all time will have been solved.

Who will say, when this is done, that we have not builded very substantially for all the generations to come?

USE OF LOCAL GRAVEL PITS IN WISCONSIN DURING 1923

By H. J. Kuelling, Construction Engineer, Wisconsin State Highway Department, Capitol Annex, Madison, Wis.

For several years past there has been a growing use of local materials for the construction of concrete roads in Wisconsin. This use consisted mainly of gravel pits with several quarry operations. Apparently there is to be a still greater use of such materials as freight hauls get longer and therefore more expensive.

An Economic Problem

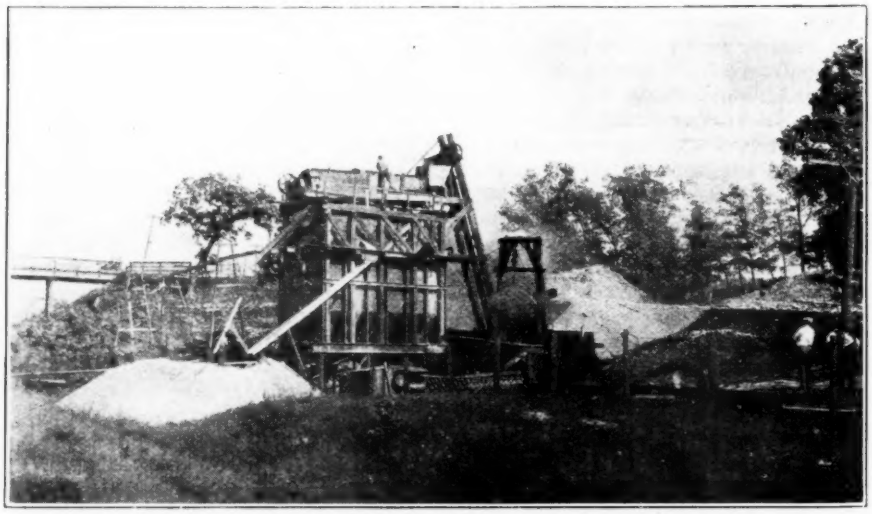
The use of local material has been determined largely by a study of the economics involved in any particular job; that is, which is the cheaper, local or shipped material? It is entirely out of the question for state or county to subsidize any commercial pit or quarry. There is no argument but what commercial plants can and do produce cheaper than any local plant, but when the question of freight enters into the argument, the handicap of 90 cts. to $1 or even more per cubic yard is too much for the commercial concerns to carry, as it is more than the average production costs of the Wisconsin local pits.

Suggestion to Commercial Producers

The writer has argued for several years past that the commercial companies instead of sitting back and criticizing, are passing up a good business opportunity by not going into local production with one or more small outfits. One commercial concern expects to enter the field with one or more of these so-called "gypsy outfits" in 1924. The writer sees no reason why such a plan would not be successful as a man who has made it his business to produce concrete aggregates is better able to do so than the average contractor. The contractor would probably welcome him in many cases, as it would enable him to give more attention to his paving work and also remove one of his hazards.

As to Quality

Occasionally one hears the question of quality raised in discussing local operations. Properly operated, as many local pits are now, just as good material is obtained as can be purchased from com-



BLOOMER, WIS., LOCAL GRAVEL PIT FOR PRODUCING CONCRETE AGGREGATE.

Note removal of pea gravel in foreground to get proper grading.

mercial concerns. Improper operation in local or commercial plants will produce unsatisfactory material as we all know who have had to reject material from both sources.

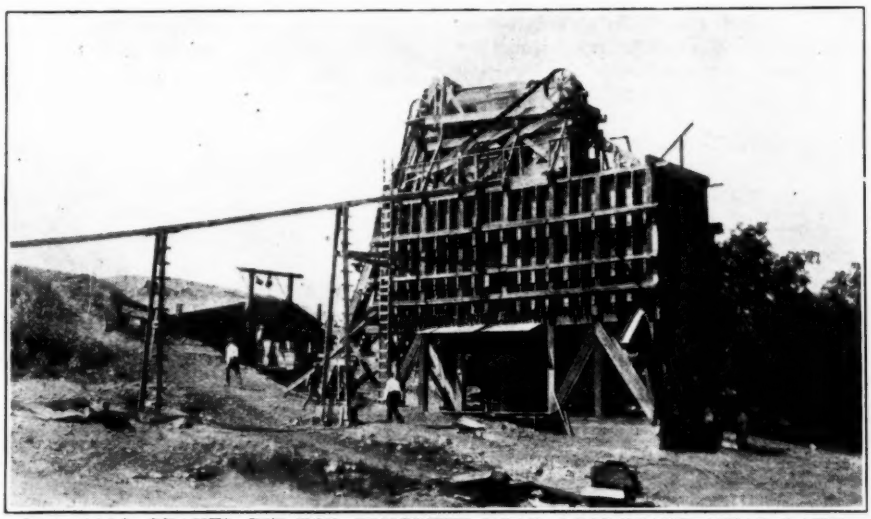
Extent of Local Pit Operations in Wisconsin

During the past season, there were 15 local plants in Wisconsin producing concrete road aggregates. These 15 plants produced material for about 97 miles of 18-ft. concrete road, a very considerable program one must admit. The amount of saving resulting to the taxpayers of the state, as compared with using commercial, shipped-in material, is rather hard to state as the evidence is largely circumstantial. The freight alone on these jobs would have been nearly $400,000. The average haul in nearly every case was less from the local plants than from a railway station, in some cases being very materially less, the reduction being several miles. The writer frankly admits that all the freight item was not a saving, as commercial plants would absorb some of it because of cheaper production. Still, when the freight, shortened haul, freedom from railway operations, more centralized operation of the entire road job, less bond cost, and easier financing of the job by the contractor are all taken into consideration, the writer feels he is conservative in estimating the saving on these 97 miles to be at least $400,000, compared with shipped-in material.

This estimate is borne out by the fact that these roads were built for as low as $1.06 a square yard on roads that averaged 7 2/3 ins. in thickness. (This price is exclusive of cement costs.)

Locating the Pits

From the standpoint of the taxpayer and of the engineer, the previous knowledge of gravel pit locations is of paramount importance. In other words, it doesn't do the community much good to let a contract and then have the contractor go out and locate some local deposits, build his road of it and pocket all the saving as additional profit. This procedure saves the taxpayer nothing and is exceedingly poor engineering.



BIRDSALL GRAVEL PIT FOR CONCRETE ROAD AGGREGATE, NEAR LAKE GENEVA, WISCONSIN, 1923.

In Wisconsin the duty of locating gravel deposits is the duty of the geologist, so all of our material parties are in charge of a geologist, just as if they were to seek a deposit of lead or iron. His knowledge of geology shows him where to seek the best supplies. This has often been brought out in a startling manner by finding good deposits where the local people insisted no material existed, and where the average layman or engineer even would not suspect it.

The duty of the engineer, who accompanies or follows the geological party, is to study the deposit from the physical standpoint of pit operation and haul.

These geological parties locate a large number of deposits and make estimates and recommendations as to quality and quantity. No pit, however, is approved

or recommended for operation until it has been thoroughly test pitted and sampled, and these samples tested in the laboratory.

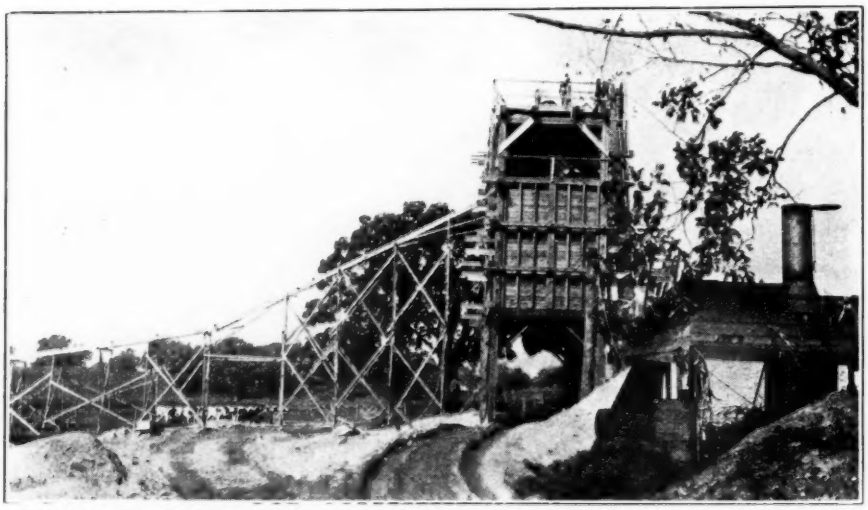
The field party first seeks material near the center of the job. If this is not available, they widen out their search, keeping in mind the question of long hauls and poor setup. They must also locate the nearest available water for washing purposes. They do some test pitting to determine the amount of stripping. They also make silt, colorimetric and screen tests. This information is turned in to the materials department of the highway commission, who passes judgment as to the advisability of ordering complete test pitting.

It will thus be seen that considerable thought and energy must be expended before the question of pit equipment and operation is considered.

Cost of Plants

Local plants such as are shown in the accompanying cuts, cost from $10,000 to $13,000 each, ready for operation. They are capable of producing from 300 to 600 cu. yds. of aggregate per day, and do so with a reasonably small crew. They have good bin capacity to carry the paving operations over small breakdowns at the pit.

Of course the entire equipment must be efficient and efficiently operated as well. Too small a crusher or screens, not enough power, poor management,



DOUGHERTY PIT FOR PRODUCING CONCRETE AGGREGATE ON CAMBRIDGE-FORT ATKINSON, WISCONSIN, ROAD.

Where test pitting is deemed desirable, it is made to such an extent that the deposit or deposits are condemned or found reasonably satisfactory as to quantity. Samples are taken from the test holes at various depths and forwarded to the laboratory in cloth sacks. These samples are tested and the material passed on as to quality.

With such procedure it is seldom that a pit fails. In some cases, economics have warranted the taking of chances on pits that were somewhat doubtful in appearance, especially as to quantity.

Cost of Surveys

The field surveys have cost from $40 to $50 per mile of project, while the testing has cost about $35 from each deposit tested.

and a poor water supply, are some of the possible trouble makers.

The Contractor's Set-Up

The contractor, in choosing his set-up and machinery, has quite a problem and will probably make a number of mistakes in his first attempt. He must consider the distance he is from the project, the amount of crushing required and also what method of hauling and charging the mixer is to be used. The method of feeding the plant should be continuous in some way rather than intermittent, as it tends to greater output and to less strain on the plant. Washing is probably necessary in all plants, to assist in separating fines from coarse, if not for cleansing purposes. There are several good devices on the market for washing

dirty gravel and also for removing the wash water, but space in this article will not permit describing them.

The Contractor's Changing Viewpoint

For several years, contractors were more or less opposed to the use of local pits, claiming it was uncertain, caused them to have more equipment and to carry on another operation. Each year, however, has found more converts and now there are a number who very much prefer jobs involving local pit operations. Some are going so far as to do their own locating of deposits, thus seeking one more advantageous than those recommended by the state or county. They have come to realize that there are advantages as well as troubles. They further realize that competition is not so keen. The writer fully realizes that the subject of local pits is a highly localized matter, but he also realizes that where local material exists, the subject is deserving of the very best engineering and contracting talent that can be given it.

In Wisconsin it has not only been a question of money savings. It has enabled us to do work which might not otherwise be done, because of long hauls and dependence on railway equipment.

YOUR JUDGMENT IS NO BETTER THAN YOUR INFORMATION

By Monroe L. Patzig, Manager Patzig Laboratories, Des Moines, Iowa

A valuable epigram expressed by a speaker at one of our club luncheons nearly a year ago, so thoroughly impressed me that I stenciled it upon the walls throughout our institution.

Thinking that it might be of equal interest to the readers of "Municipal and County Engineering," and especially at a time when our great Road Show and Convention are in progress, I am pleased to give it here: "Your Judgment is no Better Than Your Information."

It seems that this is such a true statement, and so simple if we give it a little thought, that no example or statements could make it more impressive.

To me it seems to be a "key" to efficiency, for if we all consider the information we have before adopting any form of action, opinions, advice or statements, we will not act on important matters until satisfied that the information is the best we can procure.

How often in engineering lines of work as well as in every other pursuit or occupation are seen examples of action taken upon poor or limited information. We find them in everyday insignificant matters, as well as the big things affecting individuals, communities, nations and the entire world.

Too often we find persons who have advanced to important stations in life develop impulsive natures and make quick decisions not based upon the best information obtainable. These people make many errors. When applied to the engineering profession these errors cost vast sums of money, or great loss of life. The doctor, dentist, lawyer, politician, etc., may thus also cause serious injury to others by his actions based upon slight or vague information.

Our conventions and professional publications are means for enlarging our information by the exchange of our experiences, methods, designs, tests, plans of organization, costs, materials and machinery.

Our activities of today comprise so many different subjects that we can only hope to gain sufficient information on very few of them, and thus we find men of every profession specializing upon certain branches, thereby enabling them to keep better informed on the progress made upon their respective subjects.

The wise executive, who must make important decisions, necessarily therefore must call in experts on various subjects to supply the information he does not have.

Thus the thought seems to convey the idea that efficiency in judgment or action demands a thorough knowledge of everything pertaining to that subject or relative subjects; 100 per cent efficiency requiring perfect information; less perfect information results in lower efficiency.

RESURFACING OLD PAVEMENT WITH CONCRETE AT TERRE HAUTE, IND.

An interesting resurfacing job was recently completed on West Wabash Ave., between Terre Haute and West Terre Haute, Ind. This street, which is also a portion of the National Road, is 1.24 miles long and was resurfaced with concrete in 1923. The old pavement was a brick surface on a poor concrete base. It was built in 1907, had been in very

bad condition for years, and had been patched with concrete and other materials until only a part of the original surface remained. Resurfacing was carried on under the direction of the Indiana State Highway Commission.

The old surface was swept clean and the concrete for the new surface was placed directly upon the bricks without any attempt to make it adhere to or to be separate from them. The concrete was proportioned 1:2:3 and had a minimum thickness of 5 ins. with an average thickness of 6½ ins. It was reinforced with ⅝-in. bars spaced 4 ft. center to center each way and placed 3 ins. from the top.

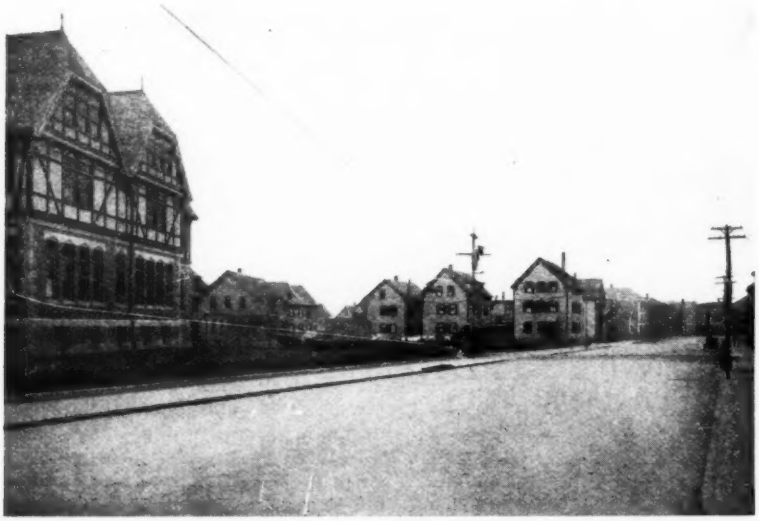


FIG. 1. FIRST PAVEMENT LAID UNDER WALLACE PATENTS, COVE ST., NEW BEDFORD, MASS.
Laid in 1910 by Warren Bros. Co.; no repairs in 13 years.

The 28-ft. pavement was built half at a time so that traffic could be maintained, and was laid, finished and cured in the manner prescribed by the State Highway Commission for regular concrete pavements.

REVIEW OF THE QUARTER CENTURY DEVELOPMENT OF WARREN ROADWAY CONSTRUCTION

By George C. Warren, Chairman Executive Committee, Warren Brothers Company, 9 Cambridge St., Boston, Mass.

The closing of full 25 years since the late Frederick John Warren began his study of the fundamental theory that the mineral aggregate of asphaltic road surface should be of a dense, stable combination of varying sizes of coarse and fine particles of crushed stone (or gravel) combined with crusher screenings (or sand) instead of the then prevalent graded sand mixtures, seems to make it timely to outline the steps of progress and improvement in this type of construction during that long period.

In the fall of 1898, Fred Warren began his study and, in experimental research, continued it for over two years before making application for his first patent. Twenty odd patents were subsequently issued covering product processes, equipment, etc., the foundamental basic patent being No. 727,505, which has become known the world over.

Early Development of Defects

The first practical construction which was laid in Pawtucket, R. I., and New Bedford, Mass., was shortly thereafter christened "Bitulithic." Those early small area trials quickly developed that the coarse aggregate mixture must have some form of finer surfacing to make the surface more impermeable to water and the elements and to protect the coarse particles of aggregate from direct contact with traffic. A fine aggregate mixture spread after compression of the dense stable coarse aggregate mixture was tried and failed because the two courses did not thoroughly unite with each other.

The fine mixture scaled off under traffic and this method was abandoned. Then a surface painting of "flush coat" of about ¼-gal. (say 1/16-in. depth) of hot asphalt, into which sand or crusher screenings were spread, was tried and for a time appeared to "fill the bill." This was the surface finish adopted and universally used until 1910.

After a few years, this flush coating wore away and left the coarse angular particles of stone exposed to traffic, which began to "play havoc" with the construction and unless frequently reflushcoated (which municipalities generally failed to provide) the pavement was more or less destroyed under heavy traffic.

During this period of ten years, notwithstanding the weaknesses which had developed, so briefly outlined above, the inherent merits of the construction were such that it rapidly increased year by year; it had proved to be an advance step over prior asphaltic pavement construction.

Wallace Invention

In the year 1910, Edwin C. Wallace, who had been associated with Warren interests beginning in the year 1893, conceived a new construction embraced in a series of four patents, the basic principle of which is:

1. A lower coarse aggregate bituminous mixture.

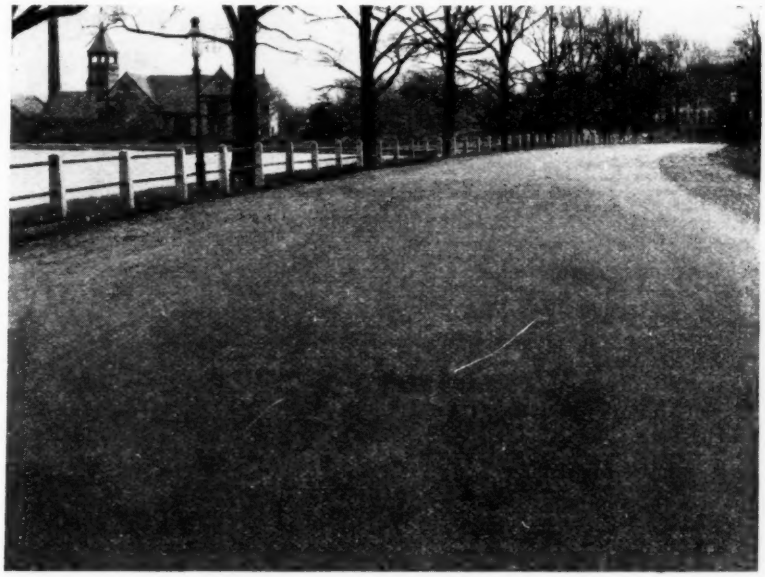


FIG. 2. ASBESTOPHALT LAID IN 1920 ON OLD CONCRETE PAVEMENT, BEACON ST., BOSTON, MASS.

The next step, in an effort to overcome this developed weakness, was the use of a surplus of "mortar" element (screenings or sand and asphalt) required to fill the voids on the theory that this surplus "asphalt mortar" would squeeze up to the surface and provide a substantial "asphatic mortar" surfacing before spreading of the flushcoat. This was partially accomplished, but under the rapidly increasing automobile traffic, opened a new weakness:

(a) Increased tendency to "shift" due to reduction of stability.

(b) "Bleeding" and undesirable gummy condition of surface in hot weather.

2. A fine aggregate bituminous mixture very rich in soft bitumen spread relatively thin over the course "1" and the two courses "bonded and blended" together by compression while the lower coarse aggregate mixture is still hot and in a malleable, compressible condition. The effect of this combination is:

(a) Stability and weight resistance in the lower part where that property is most needed.

(b) Maximum pliability, wear and element resistance and denseness at the top where those properties are most important.

(c) Between the extremes of bottom

and top and indeterminate combination of the two where the fine is pressed into the coarse, thus providing a blending of the two, so that there is no line of cleavage and no opportunity for separation under traffic or the elements. In other words, a single layer wearing surface of varying conditions from top to bottom so distributed as best to meet the separate and exacting requirements of the different portions of a pavement wearing surface section.

This construction, which began in New Bedford, Mass., in 1910, on a trial area of about 1,000 sq.yds., was so revolutionary that its wearing qualities, in comparison with those of adjacent streets laid with the flushcoat method, were watched for several years. General introduction of this improved construction was started in 1913 and 1914. It was difficult at first to get the public generally to adopt it until tried over a considerable period. For the first few years its progress was rather slow, but within eight years its improvement was so generally appreciatde that more than 85 per cent. of all coarse aggregate mixed asphaltic pavement surfaces, embodied this radical improvement. During these early years, however, the construction consisted of a lower coarse aggregate mixture, which, like the latest development under the Warren patent, contained a surplus of the mortar element which proved to have some tendency to shift under some conditions.

Asbestophalt and Asbestos-Bitulithic

In the year 1918, August E. Schutte invented the use of certain combinations of asbestos fibre, carefully selected fine aggregate and asphalt. The asbestos fibre adds greatly to the toughness of the asphaltic cement and wear-resistance of the entire construction. The high cost of asbestos and consequent increased cost of construction have been such that its adoption has not been as rapid as it would otherwise have been, but its merit is destined greatly to increase its use.

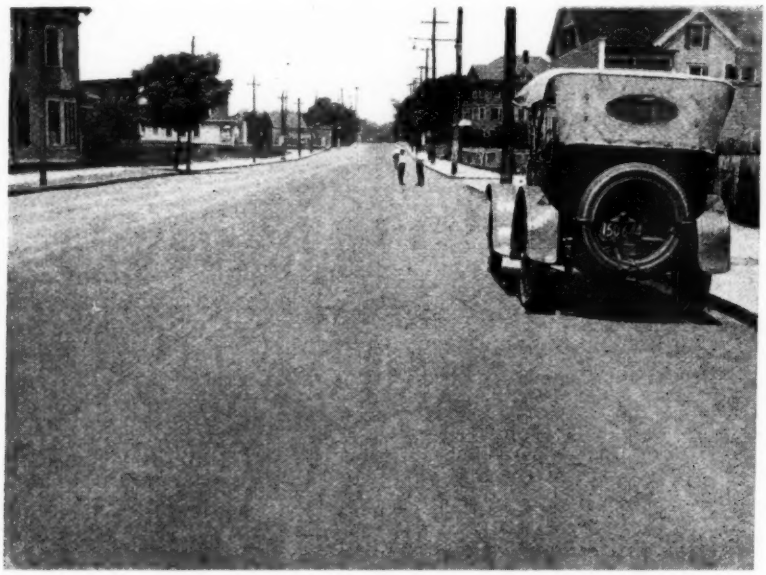


FIG. 3. ASBESTOS-BITULITHIC LAID IN 1919 ON OLD MACADAM ON BROADWAY, PAWTUCKET, R. I.

The asbestos construction embodies two distinct forms:

1. A surfacing of fine aggregate, asbestos and asphalt mixture which may be laid over any approved foundation and is especially adapted for economic surfacing of deteriorated Portland cement concrete and brick or other block types of pavement surfaces. This application is termed "Asbestophalt" and is generally laid to a depth of 1 in. over the old pavement surface. The first pavement of this type was laid over a badly cracked reinforced Portland cement concrete road on Beacon Street, Boston, alongside the Chestnut Hill Reservoir. The Asbestophalt surface was laid in the year 1920 when the Portland cement concrete road

was 3 years old. It is now in perfect condition after 3 years' practical use under the rigorous conditions of New England climate and the heavy traffic of one of Boston's leading thoroughfares. During the intervening 3 years, Asbestophalt has been laid in twelve cities to the extent of over 75,000 sq. yds. and its high merit is generally recognized. Of course, if the old pavement surfaces contain holes or depressions, they must be filled, and the surface brought to a reasonably uniform contour with new sound asphaltic binder, which is equally necessary with any other type of resurfacing.

FIG. 4. WARRENITE-BITULITHIC ON SOMERVILLE AVE., CAMBRIDGE, MASS., USING NATURAL ROCK ASPHALT AS FINE SURFACING MIXTURE.

2. The other application of the Asbestophalt mixture is for use as the fine surfacing mixture of the Warrenite-Bitulithic pavement in which it has been used, generally in trial areas only, during the past five years in 19 cities and has universally proved successful, with absolutely no repairs under exacting traffic and climatic conditions. This construction is known as "Asbestos-Bitulithic."

Natural Rock Asphalt Surfacing

In the year 1921 J. S. Burge, for nearly 40 years connected with the Warren interests, and now head of the Warren Brothers Co. Technical Department in California, invented the use of natural rock asphalt in lieu of the fine surfacing mixture of the Warrenite-Bithulithic pavement. This has been used to date only in a few sections and generally in trial areas, but is proving to meet the expectation of its inventor as an improved pavement construction. There are a few sections of the United States having deposits of high grade rock asphalt similar to the European rock asphalts, the wearing qualities of which are thoroughly established. The practical use of this improved construction is limited to sections sufficiently close to the rock asphalt deposit to permit of economic transportation. It clearly provides the best embodiment for economic use of available high grade rock asphalt.

Dense Mixed Asphaltic Concrete ("Black") Base

This construction in connection with Warren pavement surfaces has been in generally used in the far West beginning with Portland, Ore., in 1912, and is now in use in over 150 city, county and state projects to the extent of over 9,000,000 sq yds. Its use has not yet extended to any considerable extent in the eastern states, but a notable example of its use in the eastern states is Barnum Boulevard in Bridgeport, Conn., about two miles laid in the year 1920 where the total depth of base and surface is 5 ins. (3½ ins. dense asphaltic concrete base and 1½ in. Warrenite-Bitulithic surface) and is in perfect condition. The success of this construction is beyond peradven-

ture. Of course asphaltic concrete base cannot be laid at nearly as low cost per cu. yd. as some other types of base, but, on the other hand, its flexibility, resilience and shock absorbing properties, together with absolute non-raising from the subgrade and union of base and surface, and no cracking, are such that the construction may be of considerably less depth than any other type of new base under similar sub-soil conditions. It is a great improvement in economic road construction. One extremely important advantage of this construction is that it can be laid without discommoding traffic.

Double Reflushcoating Old Asphaltic Surfaces

This is an invention of Wallace which consists of:

(a) Thoroughly cleaning the old surface.

(b) Filling depressions, if any, with new asphaltic mixture.

(c) Painting with cold liquified asphalt, the liquifier being of a volatile nature.

(d) A few hours later, after the liquid material has had time to penetrate into and revivify the old surface and for the volatile liquifier to evaporate, give a heavy flushcoating of hot pure asphaltic cement of desired penetration, and while it is still hot spread and roll in stone screenings or sand. Old rough bituminous surfaces are by this method converted into new surfaces on a most economic successful basis.

Warrenite-Bitulithic on Steep Grades

By modification of the fine surfacing mixture so as to provide a well roughened surface Warrenite-Bithulithic is successfully adopted for steep grades, a good example of which is five miles of mountainous, Montgomery Road, Jefferson County (Birmingham) Ala., of which more than half is steep grades ranging from five to eight per cent.

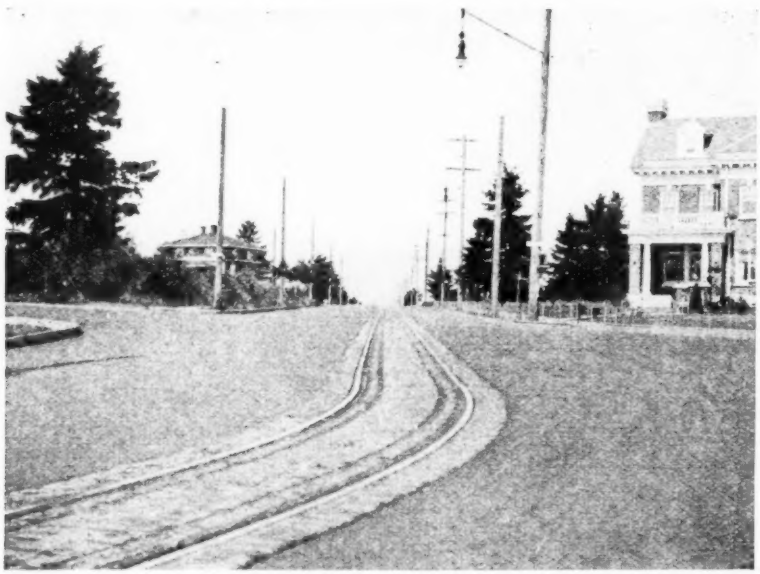


FIG. 5. WARREN PAVEMENT LAID ON DENSE BITUMINOUS CONCRETE BASE IN 1912 IN ALAMEDA PARK, PORTLAND, OREGON.

Warrenite-Bithulithic Surfacing Over Old Macadam

The successful construction of over 11,000,000 sq. yds., during the past twelve years, is proof of efficacy of old macadam as a foundation for Warrenite-Bithulitic surface.

It will be especially noted that all of this long experience has shown, that the general thought of F. J. Warren's original invention, namely, the importance of stability as well as resiliency, is correct. It has been and is still maintained, and therefore is part and parcel of each of the later inventions which produce superior and durable pavements.

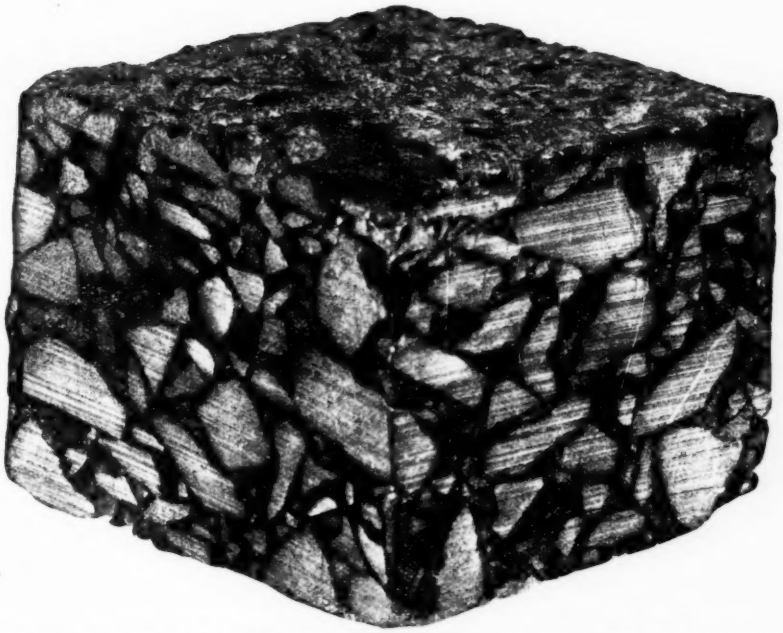


FIG. 6. BLOCK OF WARRENITE-BITULITHIC, OF HILL TYYE, SHOWING ROUGHENED SURFACE AND TWO VERTICAL SAWED FACES.
Sample cut from Montgomery Highway, Jefferson County, Ala.; laid in 1921.

Briefly stated the foregoing outlines the basic improvements which Warren Brothers Co. has accomplished in the past quarter century of close application of a large organization of practical experienced men in an effort to improve its product.

SOME RECOMMENDATIONS ON HIGHWAY MAINTENANCE PROCEDURE

(Editor's Note: Following is the text of the report of the Committee on Maintenance of the American Association of State Highway Officials, as presented at the 1923 convention. The report was submitted by J. T. Donaghey, Wisconsin (Chairman); A. H. Hinkle, Indiana; W. E. Hawkins, North Carolina; G. E. Hamline, Connecticut, and C. D. Buck, Delaware.)

The Association, at its 1922 annual meeting, outlined the scope of work for this committee for 1923, and passed the following resolution covering such scope of work:

"In order that maintenance problems may be discussed intelligently, that the growing demand for accurate cost information may be met, that the economic limit for maintenance on various types of roads may be determined, and that the states may profit by the experience of others, we propose the following scope of committee work for 1923:

"1. Definition of highway maintenance.

"2. Classification of types of roads.

"3. Establishment of comparable cost records.

"4. Establishment of methods of supervision, distribution and maintenance of equipment.

"5. Cooperation in maintenance research work."

Definition of Highway Maintenance

The Committee recommends the following definition of Highway Maintenance:

"Highway Maintenance" is the operation performed in reclaiming, preserving and keeping the road to practically its original condition for traffic. While the terms "reconstruction" or "repair" are often used to apply to extensive work done to bring the road back to a good condition after it has worn or disintegrated quite extensively, the broad use of the term "maintenance" may include

these if the work done brings the road back to near its original condition. If extensive work is done on the road that makes it stronger, wider or safer than it was originally, then such work should be classified as "betterments."

Classification of Types of Roads

The Committee recommends the following general classification:

Item 1. Earth.
(a) Selected soils, such as sand-clay, top soils, etc.
(b) Natural soil.

Item 2. Gravel.
(a) Surface treated.
(b) Not surface treated.

This type to include all other light surfacing of a stone or gravel nature.

Item 3. Crushed Stone.
(a) Surface treated.
(b) Not surface treated.

Item 4. Waterbound Macadam.
Surface treated.

Item 5. Natural Rock Asphalt.

Item 6. Bituminous Macadam.
Penetration.

Item 7. Bituminous Concrete.
This type to include all pre-mixed bituminous surfacings.

Item 8. Cement Concrete.

Item 9. Brick.

Item 10. Stone Block.

Item 11. Wood Block.

Establishment of Comparable Cost Records

The Committee recommends the following distribution of highway maintenance expenditures, which we believe will enable the different states to furnish comparable cost records:

1. Maintenance administration.
2. Maintenance proper.
   (a) Roadbed (repairs to sub-base, shoulders, ditches, underground drains, cutting grass, weeds, brush, etc.).
   (b) Surface (to include all expenditures to road surface from bottom of road base to top of wearing surface, including oiling, surface treatments, etc., except the first surface treatment which should be charged to "betterments.").
   (c) Structures (including bridges, culverts, walls, guard rails, etc.).
   (d) Snow removal.
3. Betterments.

To include expenditures for the increased permanent value of the road to accommodate traffic.

   (a) Roadbed (increased width of roadbed, improving drainage, grades, alignment and vision).
   (b) Surface (increased width or depth of wearing surface over original maximum widths or depths. Also the first surface treatment).
   (c) Structures (new drainage, structures, walls, guard fence, etc.).

4. Markers and Signs.
   To include center line and other pavement markers.

5. Parks, Camp Sites and Roadside Beautification.

Establishment of Methods of Supervision, Distribution and Maintenance of Equipment

The Committee recommends that all maintenance equipment while in the field be under the direct control of the local maintenance supervising authority, but it is not agreed as to the advisability of maintaining a central repair department.

The Committee also recommends the following scope of committee work for 1924:

1. Study methods and costs of maintaining gravel surfaces with bituminous surface treatment.

2. Determine the best specification for asphalt and tar fillers for concrete pavement repair in various sections of the country.

3. Make a study of snow removal equipment with the end in view of developing equipment especially adapted to highway work.

4. To determine, if possible, a unit of comparative wear, and carry on research work to show maintenance costs per such unit on various representative roads of different types.

ACCOUNTING OF MUNICIPAL PUBLIC UTILITIES

By Allen Munn, Chief Clerk, Municipal Accounting Department, Office of Auditor of State, Des Moines, Iowa

I believe a uniform system of municipal utility accounting should be added to the state report, so that valuable data pertaining thereto, and a comparison of

such utilities could be made in such report.

Utility accounting has not been placed under a uniform system in Iowa, and we can not say that we have a complete uniform accounting system until it is included.

It is true that our annual report mentions utilities and requires a report of cash received and disbursements therefrom, but no report of detailed plant operation.

The state auditor's office has already recognized the need of the establishment of a uniform system of utility accounting, and has taken some measures in that direction.

If, in the future, the state should require a detailed accounting of municipally owned utilities as to the financial result of their operation, it should also require in some measure a report from the privately owned utilities.

The municipal utility accounts for each utility owned and operated by the city should be kept distinct from other city accounts, and kept in such a manner as to show a true and complete financial result of the operation, which should embrace and include all assets, liabilities, revenues and expenses, actual cost to the city of each utility owned, cost of extensions, additions, cost of maintenance, and all operation expenses of every description, sundry stock account used for maintaining and extending the plant, also sale stock account of general supplies to be furnished to consumers of service. In fact, a complete plant record should be kept so that a comprehensive report covering in detail the utility plant operation to the effect that the actual cost of producing a kilowatt of light, or 1,000 ft. of water or gas can be shown upon which to base an intelligent charge to consumers and the establishment of the proper rates therefor; without such an accounting, the utility is being operated in a blind and guesswork way, and the consumer and taxpayer are not being well served or their interest guarded.

A tax levy made for light or water works or any municipal utility should not be considered as earnings of the plant, as often times when this is done, if the real facts were known and the levy discontinued, a plant would be operating at a loss.

The use of accounting in judging efficiency of utility operations is dependent upon a correlation of accounting and statistical data; the accounting records alone do not provide a perfect standard to base such judgment upon, because of the absence of the profit and loss test in municipal operation, none the less there is urgent need of comprehensive reports covering the operations of the utilities; and the forms of such reports should be designed to answer all questions vital to the operation of the plants, and made previous to the designing of the uniform accounting system.

Owing to the great difference in size of utilities, it would be necessary to have two classes of reports prepared. Under Class A, utilities operating in cities having a population of 7,000 or more, and all other plants under Class B.

The Auditor of State should be given the power to prescribe the forms of all record books, and as to the manner in which they shall be used for the utilities.

Each utility should furnish to the State Auditor an annual report, showing in detail:

1. An operating and non-operating revenue statement.
2. An operating expense statement, such as salaries and wages, material and supplies, and miscellaneous expense.
3. A maintenance expense statement for upkeep such as repairs or replacements.
4. A betterment statement, such as new improvements, etc.
5. A cost statement, showing the cost paid by consumer.
6. An asset and liability statement.
7. A profit and loss statement.
8. A surplus or reserve statement.
9. An inventory statement of stock on hand.
10. A depreciation statement, and in addition any information that is necessary for a full and complete report.

The State Auditor should have authority to make an annual audit of the affairs and accounts of all utilities operating in the state.

The foregoing paper by Mr. Munn was presented before the 1923 meeting of the League of Iowa Municipalities.

VALUABLE TRADE LITERATURE

(Copies of the literature here briefly reviewed may be obtained by writing to this magazine or to the addresses given in the reviews.—Editor.)

Motor Driven Pumps—In a pamphlet entitled "Efficiency Tests of De Laval Motor Driven Pumps," the De Laval Steam Turbine Co., Trenton, N. J., publishes the results of efficiency tests upon several large units installed in municipal water works plants. In sizes ranging from 300 to 1,500 h. p. each, these units show overall efficiencies, including pump and motor, between 75 and 82.5 per cent, making possible highly economical pumping where the power is obtainable at a low price from central stations. The pumps themselves now show efficiencies practically equal to those of the best hydraulic turbines of similar capacities. A 20,000,000 Imp. gals. per day pump at Toronto, for example, showed an efficiency of 87.2 per cent, and another pump of about the same size at Baltimore is credited with 86.9 per cent, while a 12-in. pump at Newton, Mass., designed to deliver 2,000,000 gals. per day, showed an efficiency of 83.8 per cent. In view of the high efficiency of the modern motor driven centrifugal pump, and also because of its moderate requirements for space, housing, attention and supplies, this type of unit deserves careful consideration in many situations.

Centrifugal Pumps—The new 72-page catalog issued by the De Laval Steam Turbine Co., Trenton, N. J., exhibits the marked development which has occurred in the improvement of centrifugal pumps, as well as in the direction of larger size and wider use. The rapid extension of the field of the centrifugal pump has been in large part due to improved efficiency, simplicity and ease of maintenance. The casings are split horizontally so that internal parts are at once accessible upon lifting the cover. De Laval pumps are stated to be manufactured to limit gages, assuring interchangeability, so that renewals can be inserted by unskilled men, as they do not require to be fitted and no adjustments of any kind are required. Centrifugal pumps driven by steam turbine or electric motor are used almost exclusively for circulating condenser water, and are also extensively applied for feeding boilers at the highest pressures. In water works service, centrifugal pumps driven by geared steam turbines are built in sizes up to 5,000 water horsepower and over, and realize duties closely paralleling those of the best triple expansion crank and fly wheel pumps. The aggregate daily capacity of water works units built by the De Laval Company alone exceeds four billion gallons. Large electric motor driven pumping units show efficiencies from wire to water exceeding 80 per cent, the pumps themselves developing efficiencies as high as 87.2 per cent. Centrifugal pumps are widely used for fire protection and may be driven by electric motor, steam turbine or gasoline engine. Gasoline driven pumps are often provided as stand-bys to motor driven pumps. In the industries centrifugal pumps are used extensively not only for general water service, but also for handling water containing solids in suspension, such as paper pulp or rags, and for pumping chemicals.

Pavement Expansion Joints—A booklet of 32 6x9 in. pages, entitled "Insured Results With Concrete Paving," has been issued by the Philip Carey Co., 40 Wayne Ave., Lockland, Cincinnati, Ohio, in illustrating and describing the accomplishments of Carey Elastic Expansion Joint in concrete road construction. Thousands of millions of feet of this joint are in use today, safeguarding concrete pavements and other structures from expansion cracks and buckles. This joint, because of its construction, has been called the "sandwich joint." It consists of a body of tempered asphaltic compound, inseparably bonded between two walls of asphalt saturated felt. While asphalt itself is not compressible, being merely displaced under pressure, the asphaltic compound in Elastite is capable of compression within its own volume, because of its combination mechanically with fibrous material chemically treated to provide innumerable air cells. Elastite is made in widths, lengths and thicknesses as required, can be cut to crown or in any special shape, and comes to the job ready to use. It does not lead to loss, waste, inconvenience or delay. Its installation and maintenance costs are negligible. The uses of the material in pavement, sidewalk, curb, bridges, viaducts and similar engineering structures are attractively illustrated and adequately described in this booklet.

Fulton-Diesel Engines—The Fulton-Diesel engine is fully illustrated and described in catalog No. 805, of 32 8½x11 in. pages, recently issued by the Fulton Iron

Works Co., of St. Louis, Mo. This is a stationary, vertical, 4-cycle engine, operating on the familiar full-Diesel principle; that is, ignition solely by heat of compression in the cylinders. This book is written for executives as well as engineers and technical men, and the contents are well within the understanding of the average business man. In addition to many large half-tones showing actual installations in the field, the rugged units and patented features of the engine, and also the heavy machinery employed in its manufacture, are profusely illustrated. Among the unique features not usually found in catalogs of this nature, are a series of half-tones picturing each successive step in the erection of the engine, and a conventional diagram showing the elements of the Fulton-Diesel.

Centrifugal Volute Pumps—Bulletin No. 126-3 illustrates and describes some of the larger pumps built by the D'Olier Centrifugal Pump and Machine Co., 165 Broadway, New York, N. Y. Especially interesting is the illustration of one of three low lift pumps recently completed for the city of Detroit filtration plant.

Ak-wa-falt—"Ak-wa-falt," an asphaltic material for cold application, composed of asphalt, water and filler, is described in a folder recently issued by the United States Asphalt Refining Co., 90 West St., New York, N. Y. The uses of this material in the construction, repairing and surface treatment of various types of sidewalks, roads and pavements are described.

Drafting Machine—"Sustaining the Draftsman's Energy" is the title of an illustrated folder issued by the Universal Drafting Machine Co., Cleveland, Ohio, to present the merits of its well-known mechanical aid to the draftsmen.

Whitewash and Cold Water Paints—Bulletin No. 304-B, issued by the National Lime Association, 918 G. street N. W., Washington, D. C., is based on chemical experimental work conducted by the Association. The formulas given are simple, easy to prepare and use, and have all been subjected to practical tests. Complete information as to the best methods for preparation and use are given in plain language. The formulas presented are considerably simpler and more economical than most of the mixes now commonly used, as well as being weather proof and non-rubbing. Engineers, architects and contractors frequently have occasion to require a simple but durable cold water paint or whitewash for use in basements, field offices, bunk houses, etc., and the Association offers its recommendations in this bulletin.

Lime and Lime-Cement Brick Mortar—This is the title of Bulletin No. 300-A, recently issued by the National Lime Association. It was prepared in response to repeated requests from engineers, architects and contractors who wanted a short and easily read, but accurate summary of the properties of lime in mortar. The essential features of mortar in the wall, cohesive, adhesive and compressive strength, water-tightness and economy are discussed. A number of letters from chimney construction companies and other users of mortar who require maximum results from the mortar they use are presented to show that lime or lime-cement brick mortars have successfully met their requirements and passed the final tests of satisfaction on the job.

NEW ROTARY SNOW PLOW FOR FORDSON TRACTORS

Officials responsible for keeping open city streets and state highways during winter are showing great interest in the new rotary snow plow for Fordson tractors recently perfected by the Dallmann Machine & Mfg. Co., Milwaukee.

In designing and perfecting this plow the Dallmann engineers have profited by the experience of manufacturers and users of snow plows operated by power other than that of the Fordson. For example, the Dallmann Fordson snow plow is designed to clear but a single track, instead of attempting to open the road to its full width.

In operation the plow can be driven in high gear through the average fall of snow and will clean a path wide enough for one-way traffic. The return trip over the same route clears the snow from the opposite side of the road.

The power take-off and transmission design is fully covered by patents allowed and pending. Power is first taken from the tractor through a specially designed Smith unit which, instead of terminating in a conventional pulley, as in the ordinary Smith unit, transmits power through a pair of spiral bevel gears, enclosed in a grease-tight housing, through a heavy, special composition steel propeller shaft, a sturdy heavy duty universal joint and forward drive gears.

A notable construction feature of this snow plow is that the plow itself, with

apron and snow propeller, rides on its own wheels, which are of the pivoting caster type. Since the entire mechanism is free to rise and fall with the inequalities of the road, all strain on the tractor as well as on the driving mechanism is eliminated.

Through the use of the Smith unit method of power take-off, the Dallmann snow plow can be used to "buck" heavy drifts, since the driver, when he sees a piece of difficult going ahead, can shift into low gear and allow the machine slowly to eat its way into the accumulation of snow, with very little probability of its stalling. A special starting device, which enables the operator to spin the motor, assures an easy and quick start when the plow is in place.

The attachment of the Dallmann snow plow is simple. Brackets bolted on either side of the crank case provide a pivoted anchorage. In attaching these brackets the studs and nuts connecting the two sections of the Fordson crank case are utilized, and since no drilling or tapping is required, the use of the plow in no way alters the tractor itself.

In operation the scooping action of the apron, combined with the forward motion of the tractor, piles the snow up in front of the propeller. This propeller, rotating at high speed, bores into the snow, slicing it off and whirling it to the side of the road. The high speed at which the propeller works and the small quantity of snow handled by each blade at one time, provides a large margin of safety against clogging.

The advantages of the Dallmann snow plow may be summarized as follows: It is the most inexpensive power snow plow on the market. It can be operated over any type of road within reason, owing to its ability to accommodate itself to the irregularities of road surface. With the positive clutching and de-clutching action afforded by the Smith unit power take-off, any tendency to stall in a heavy drift can be anticipated and prevented by "easing up" on the forward motion or by backing up, thus allowing the propeller to clear itself of the accumulated packed snow. The compactness of the plow commends itself to those whose storage space is limited, and its sturdy construction makes it ideal for use on general highway maintenance, where a steady pace must be maintained over long stretches of road.

Those interested in obtaining additional information can secure it from the Dallmann Machine & Mfg. Company, 933 Winnebago St., Milwaukee, Wisconsin.

NEW SNOW PLOW ATTACHMENTS FOR TRACTORS

The plow department of the LaPlant-Choate Mfg. Company, of Cedar Rapids, Iowa, has designed two special snow plows for track-laying tractors, as illustrated herewith.

The small size is designed for use with the 5-ton tractor, and is made in the shape of a blade plow. The blade is 10 ft. long, and the mold-board is so curved and tilted that the top is on the same level and is practically on a vertical line with the cutting edge, which permits the snow to roll back to the back of mold-board and prevents a head of snow which would be caused if the mold-board did not have correct shape.

The plow proper is attached to a main frame which surrounds the tractor. The frame is pushed from rear draw-bar of tractor, and is guided in front by special guides which push against the side-frame of tractor.

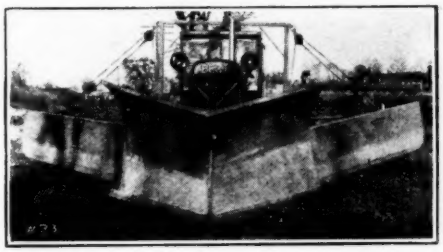
The blade is pivoted in the center on the swing-frame, and can be set perfectly straight or at a 15 deg. angle, and can be swung to either side so that snow can be thrown to one side or the other of road.

Plow is raised or lowered by means of a worm-geared windlass operated by means of a hand-wheel in tractor-cab, so that the outfit is a one-man job. The front frame is supported by two wide curved steel runners. The drive of the plow is from the rear draw-bar through to the main frame, and thence to the swing-frame. The point of contact on the main frame is back towards the rear, just past the center line of the tractor.

The shoes are placed under front only and the pivot point is placed back as close to the line on the radiator as possible, to enable the tractor-driver to properly steer the tractor without difficulty; besides it shortens up the entire length of the job.

The front of the swing-frame comes to a point the shape of an "A." The blade is pivoted to this center point and adjustable to the different angles right or left, by means of two telescoped pipes, which can be put in or out to get various extended lengths. The forward ends of

the pipe are pivoted at the end of the blade by special castings, and passed through a guide slot in the front member of swing frame, and the rear end of telescope pipe is attached to the swing frame. The ends of the pipe are attached to the main swing frame by means of a yoke which is riveted to the main swing frame, and when the blade is adjusted at 40 de-



LA PLANT-CHOATE "V" TYPE SNOW PLOW.

grees angle, the hitch point on one side is advanced towards the front, which helps the tractor driver in fighting a headon resistence when the blade is set at an angle.

The blade plow is used for city work, for industrial plants and where the snow is not too deep. For deep heavy drifted snow, such as is found on highways, the LaPlant-Choate Co. has developed a large "V" type plow which is called the "Drift-Breaker."

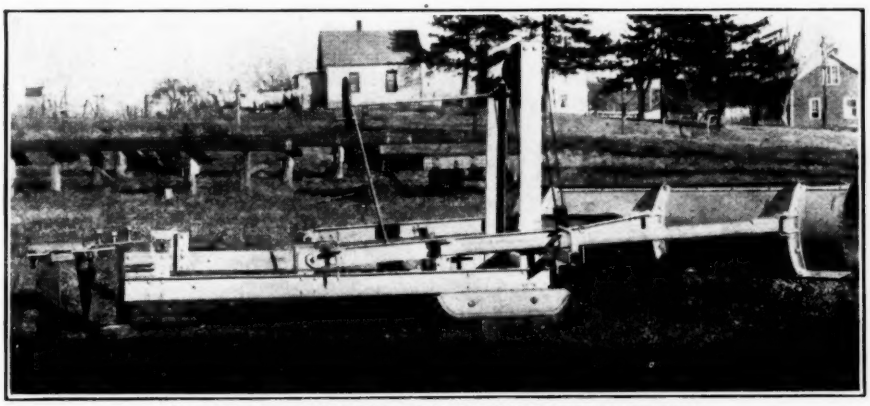
The large "V" plow has a special moldboard shape, which gets a rolling action on the snow, rolling it towards the back and lifting it up. The plow is 12 ft. wide at the rear of the "V." The main "V" is attached to a swing frame which is secured to the main frame by means of two pivotal points and the front end of "V" is supported by a hydraulic jack, which is operated from oil pump mounted at rear of tractor. Plow can be raised or lowered by means of a lever operated in the cab, enabling operator to raise plow 20 ins. in seven seconds, so that plow can be elevated quickly to cross a railroad track, obstruction, or made ready for transportation to a new point where snow is to be plowed.

This hydraulic lifting device is a novel feature, and is working very satisfactorily. Zero oil is used in the hydraulic pump, which will not freeze in the very coldest weather.

The hydraulic feature does away with one extra man on the crew, enabling the outfit to be manned by the tractor-driver and one helper. All the helper has to do is elevate the side-wings. The side-wings are 12 ft. long and 3 ft. high, fitted with cutting edged blades of steel.

The wings can be raised in front at the pivotal point 3 ft., and at the rear about 8 or 9 ft. These wings are so supported, that they can be swung in or out by means of adjustable guides or braces, so that they can be folded in close to the tractor, allowing transportation to pass, or where the snow is too deep to have wings extended. The wings can be adjusted at an angle of 15 to 40 deg., so that the sides of banks can be shaved off, thereby preventing them from drifting.

The plow is heavily reinforced, and the heavy draw-bar at the rear is so constructed that in heavy siow-fall under extreme conditions, two 10-ton tractors can be used to double-head and push the plow. The plow itself is an independent unit from the tractor and whenever desired tractor can be backed out of the main plow frame by removing two king-



LA PLANT-CHOATE BLADE TYPE SNOW PLOW.

bolts. The main frame is held in position against the side motion by guides bolted to the front end of swing frame on each side of tractor, so that when the tractor turns either to the right or left, the guides push against the frame of the plow, causing them to adjust one way or the other.

The frame being separate from the tractor allows the frame to follow the general run of the road, and oscillate over uneven places, and therefore it is independent of any up or down movement of the tractor. This means that the plow can operate on a side slope, or over very uneven ground, which is an important feature where roads are being cleared in badly drifted localities. The front of the plow is fitted with a heavy steel casting which comes to a sharp point so that it wedges in underneath the ice and frozen snow, and presses to both sides, the same as the "V" type plows used by railroads for the past 30 years. When the sidewings are extended, the plow can clear a path 30 ft. wide.

In attaching either one of these plows to a standard track-laying tractor, no alterations are necessary to the tractor. This simple method of attaching to the tractors, means that the tractors can be disconnected and used for other work without loss of time.

NEW TWO-UNIT PORTABLE ASPHALT PLANT

The East Iron and Machine Co., of Lima, Ohio, manufacturers of the Merriman railroad asphalt plant, announce an entirely new type of two-unit portable road plant; a small plant with a big capacity, quickly and easily set up, and which is loaded on one flat car for railroad shipment. This plant is absolutely complete in two units, and includes boiler and steam melting kettles. There are no extra parts to ship or handle in any way.

The plant was designed and engineered by C. C. Mosher, general manager of the company, who is also responsible for the changes and improvements on the Merriman plant during the past few years; the new plant is called the "Mosher."

Several years ago Mr. Mosher concluded that asphalt plants could be improved considerably and made to operate much more efficiently at a lower cost, so he visited all sections of the country to get information on general conditions and see all kinds of asphalt plants at work on the job. Then he began working out the improvements on the Merriman, and designing a small road plant with steam melting kettles that would be really portable in the true sense and could be set up quickly and easily packed for shipment. The Mosher two-unit portable plant is the result.

It has a capacity of 1,800 yds. a day, a new type drum and a 9-ft. mixer. A 75 H. P. special built quick steaming boiler furnishes steam for the engines, the 4,500-gal. steam melting kettles and the asphalt pump. The plant is equipped with oil burners under both the drum and boiler, also with grates for coal burning, so a choice of fuel can be had at all times. The engines are all driven direct. There are no belts to cause trouble. The plant is strong and husky, but very light, one unit weighing about 17 tons and the other about 13 tons. This weight covers the entire plant, including the melting kettles and the large boiler, which has a surplus capacity. Another feature is electric motor drive for the entire plant instead of steam engines. When motors are used, a smaller boiler is put on the plant for steam melting.

An ordinary plant crew can set the plant up for operation in about six hours and pack it for shipment in still less time. Each unit is easily trailed over ordinary roads. They set nicely on well constructed frames, mounted on trucks having wheels with a 12-in. face.

Because of its extraordinary portability, ease of setting up and handling, this plant will be a valuable unit for the contractor who wants to handle small jobs, or jobs not conveniently located near railroads, also as a fill-in unit for contractors using large car plants.

NEW LINK-BELT "TARK" SEWAGE SCREEN

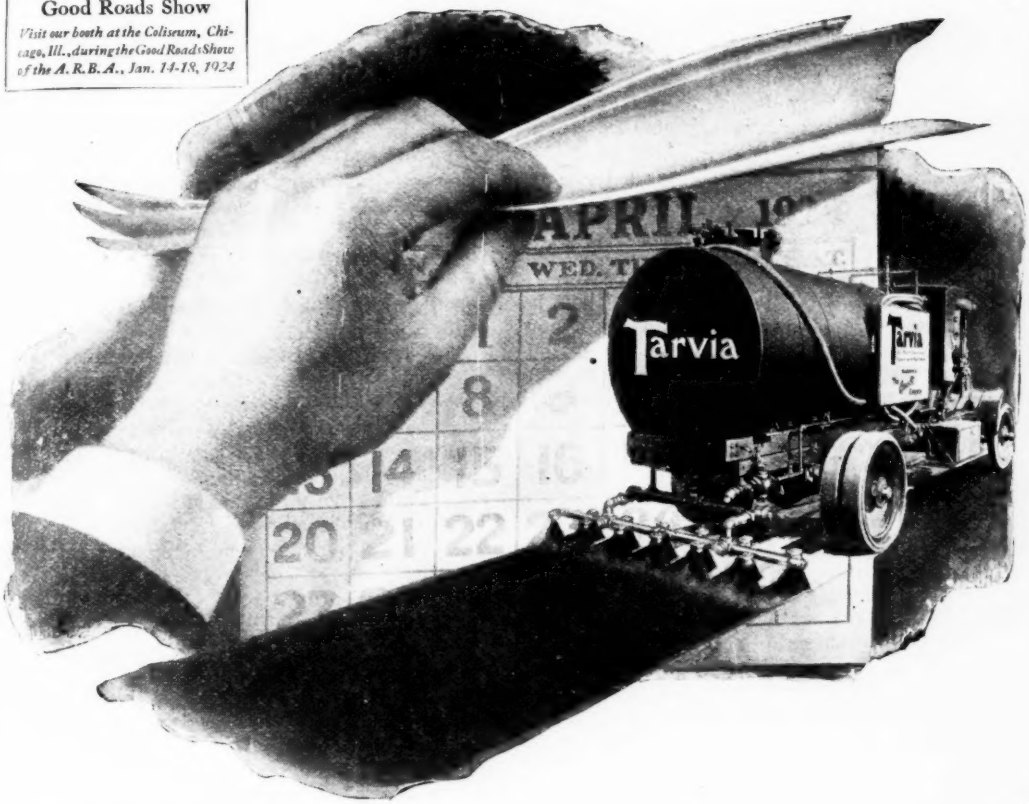
For the next twelve months the attention of sanitary engineers will be focused on Milwaukee, where the largest activated sludge sewage disposal plant in the world is now nearing completion.

Under the direction of T. Chalkley Hatton, chief engineer, a group of buildings, aeration tanks and sedimentation tanks, covering an area of 30 acres on Jones Island, are now being constructed, after some six or eight years spent in preliminary studies and experiment.

The district served by the Milwaukee

Good Roads Show

Visit our booth at the Coliseum, Chicago, Ill., during the Good Roads Show of the A. R. B. A., Jan. 14-18, 1924



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sewerage system includes, in addition to the city of Milwaukee, a number of nearby towns, the territory drained by the sewers comprising an area of 96,800 acres with a population of nearly 600,000 persons. The dry weather flow of sewage in this area is at present about 75,000,000 gallons daily, but the plant is designed to treat 300,000,000 gallons daily, this (it is estimated) being the volume of sewage that will have to be handled in 1950.

The sanitary sewage and trade wastes originating in Milwaukee county will be brought to the disposal plant on Jones Island through a comprehensive system of intercepting sewers terminating in four siphons (2 low and 2 high level, but under the harbor entrance 75 ft. below water level.

The raw sewage, after passing through bar screens to remove large materials, flows through grit chambers where the mineral matter settles out. From the grit chambers the sewage passes through Tark screens—a new type of fine screen developed by the Link-Belt Company—the effluent passing from the fine screens into an aerated conduit where it is mixed with 15 to 20 per cent by volume of activated sludge returned from the sedimentation tanks. The sewage and sludge, called "mixed liquor," is then distributed to the aeration tanks, in the bottom of which are filtros plates through which air at 8 to 10 lbs. pressure is forced so as to produce a continuous stream of tiny bubbles.

After six hours' contact with air and returned sludge, about 95 per cent of the organic matter in the raw sewage is precipitated and a remarkable purification is effected. The "mixed liquor" finally passes into sedimentation tanks where, after approximately 30 minutes' settling, the granular precipitate settles to the bottom and the purified effluent flows out at the top and is discharged into a conduit emptying into Lake Michigan.

In the brief time of 6 to 7 hours the raw sewage undergoes such purification that the liquor emptying into the lake is as clear and colorless as drinking water and will show an average reduction of 98 per cent bacteria and 97 per cent suspended matter.

One of the interesting features of the new Milwaukee sewage disposal plant is the battery of 8 Tark screens which will be used for the fine screening of the influent. In practically all modern systems of sewage disposal fine screens play an important part, and the Tark screen is interesting as being the most recent development in the art of screening municipal and industrial wastes.

Each screen is a self-contained unit, consisting of a rotating drum (carrying the screen plates), a number of revolving brushes which constantly sweep the surface of the screen (permitting the use of fine apertures without danger of clogging), and motor and reducing gears mounted on a steel frame which extends across the influent channel above the drum.

The drum itself is installed in the influent channel across the line of sewage flow. The liquid portion of the sewage after flowing through the apertures in the screen plates, passes through one end of the drum into the effluent channel, while the intercepted solids are swept from the outside surface of the drum into a sludge bucket, or mechanical conveyer, by the revolving brushes previously mentioned.

At intervals in the drum, slots are left between the screen plates from which curved metal "fins" protrude. These "sludge reclaiming plates," as they are called, serve to scoop up sediment from the bottom of the influent channel, as well as the scum that accumulates on the surface of the sewage, and carries all such debris up to the brushes, which sweep it away. A cam mechanism automatically retracts the sludge reclaiming plates to a position within the drum as they approach the brushes.

The drum is built up of small curved sections of perforated plates.

The first two screens of the Tark type were installed in the sewage disposal plant of the little town of Pleasantville, New Jersey (five miles from Atlantic City), in August, 1921, and it was the performance of these screens, and their freedom from trouble and repair, that led T. Chalkley Hatton, chief engineer of the Milwaukee Sewerage Commission, to adopt them after his return from a European trip, during which he visited most of the largest and most modern sewage disposal plants of Europe.

The Tark sewage screen is made at the Nicetown (Philadelphia) plant of the Link-Belt Company, and is fully described (together with some interesting data on the Milwaukee and Pleasantville installations) in a 16-page illustrated bulletin recently issued by the Link-Belt Co., 910 S. Michigan Ave., Chicago.

Contracts Awarded

ROADS AND STREETS.

Ala., Birmingham—City let following street paving contracts: 18th Court, to Morgan Hill Paving Co., at $4068; H. N. Bowdry, at $36.528 for Bush Blvd—8th Ave., to Ensley, and at $10,597 for 24th St.,—7th to 8th Sts.; Birmingham Ry., Light & Power Co., for 8th Ave. W.,—all Birmingham.

Ala., Birmingham—Southern Roads Co., New Orleans, La., awarded contract by Jno. J. Nyhoff for impvts., at Sheffield Heights, at $54,000.

Ark., Little Rock—P. F. Connelly Constr. Co., Little Rock, awarded contract for improving E. 2nd, Cumberland, Rock, Byrd, Commerce, Sherman, Ferry, Collins and Rector Sts., in Dist. 356, at $1,44 sq. yd. for 3-in. asph. top, 6-in. conc. base, $1.35, etc. Total, $75,085.

Ark., Mena—Western Construction Co., Little Rock, awarded contract for grading and gravel surfacing 16 mi. Mena—Egger Bwy., 18 ft., at $90,000.

Ark., Walnut Ridge—C. Hager, Walnut Ridge, awarded contract for grading and gravel surfacing in Road Dist. No. 8, at $50,000.

Cal. Compton—G. H. Oswald, 366 E. 58th St., Los Angeles, award contract for impvt. of Wilmington St.,—72,800 ft. grading, 72,000 sq. ft. 5-in. conc., steel and conc. culverts, curbs and walls at $30,500.

Cal., Los Angeles—Griffith Co. Railway Bldg., awarded contract for grading, curbing, paving, etc. portion of O'Farrell St.,—160,223 sq. ft. asph. pavement, at $64,900.

Cal., Lynwood—Hall-Johnson Co., Post Office Box No. 51, awarded contract for paving Agnes and Cedar Sts., etc., 4-in. macadam, at $92,260.

Cal., Oakland—Contract for paving 5th St., Harrison to Oak St., to Heafey, Moore & McNair, 2030 High St., 52,500 sq. ft. grading $0.05, 50,400 sq. ft. 2-in. Warrenite bitulithic on 6-in. conc., $0.30, etc.; 75th Ave., Beck St. N. E., to Hutchinson Co., Hutchinson Bldg., 35,567 sq. ft. grading, $0.035, 15,982 sq. ft. oil macadam pavement, $0.11, 7,022 sq. ft. cement walks, $0.16, etc.

Cal., Redwood City, Cal.—Municipal Impvt. Co., 12th St. awarded contr. by San Mateo Co. for impvt. of various streets in Lomita Park Rd. Dist. 2; 16,000 c. y. excav., 542,900 sq. ft. 4-in. conc. base with 1½-in. Warrenite-bitulithic surf., etc., at $211,495.

Cal., Sausalito—McDonald Impvt. Co., Pacific Bldg., San Francisco, awarded contract for impvt. of Princess St., at $36,380.

Cal., Visalia—Valley Paving & Constr. Co., Visalia, awarded contract to improve W. Center and N. Giddings Sts., etc., 4,631 c. y. grading, 212,757 sq. ft. 1½-in. Warrenite bitulithic on 4-in. base, etc., at $58,997.

Colo., Denver—J. Collier, 63 S. Logan St., awarded contract for curbing, grading and surfacing 1 mile N. Denver Impvt. Dist. 33, ¼-mile wide, at $103,000.

Fla., Clearwater—Pinellas County Commrs. let contracts at $2,416,151 for 3 brick and asph. blocks, with bitum. filler, roads as follows: Gandy Bridge Rd. to Cone Bros., Tampa; from Tarpo Springs to St., Petersburg, starting on outskirts of Clearwater, to Peninsular Construction Co., Tampa; from Clearwater to Safety Harbor and Oldsmar to Davis & Miller, St., Petersburg.

Fla., Tallahassee—Following contracts let by State Highway Dept.; Proj. 521, Nassau Co., 12 mi. Waycross Rd., rock base and surf. treatment

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from 5 miles no. of Callahan to St. Marys River, Morgan Hill Paving Co., Miami, Fla., at $277,846; Proj. 40-E, Brevard Co., 13.59 mi. State Rd. No. 4, from Titusville no. to Voluska Co. line, Langston Constr. Co., Titusville, Fla., at $286,564; Proj. 604, Volusia Co., 7.72 mi.—New Smyrna to Rosebay,—to C. F. Lytle, Jacksonville, Fla., at $191,432; Proj. 571, Madison Co., Madison to Greenville, 14.73 mi., Hunter & Gladwell, Lake City, Fla., at $85,900; Proj. 544-8 Pasco Co. 13.3 mi. State Rd. 5, Hernando Co. line so. to Proj. 544-A, Barber Fortin Co., Jacksonville, Fla., at $270,054; Proj. 544-A, 8.75 mi. from the Hillsborough Co. line no. to No. 544-B, F. S. Whitney, St.

Ind., Indianapolis—Lowell F. Parker Co., Bloomfield, awarded contract by County Commrs., for constr. of new 3-mile concrete pavement in Washington Twp., at $106,700. Work on grading road will begin as soon as bonds are sold by Co. Treas. Highway will be 100 ft. wide as far as 71st St., and from that point no. 70 ft. Pavement will be 20 ft. Rd. is known as Edwards road. Impvt. begins at 64th and White River and proceeds N. W. to Meridian, no. to 71st, east to Penn. and no. to 86th.

Ia., Clinton—McCarthy Impvt. Co., Davenport, awarded contract for paving in Clinton Co. on F. A. P. 204, at $463,000. 14.53 miles primary road bet. Lyons and Charlotte; 38,370 cu. yds. earth excav., 159,738 sq. yds. conc. pavement; 36 single and 5 double special intakes.

Ia., Sioux City—C. F. Lytle Constr. Co., 504 Nebraska St., Sioux City, awarded contract for paving in Woodbury Co., on F. A. P. No. 2, at $509,177, 16½ miles Moville-Correctionville Rd.

Kans., Independence—A. G. Sherwood, Independence, awarded contracts for grading and bitum. macadam surfacing 5.14 miles Chimney Rd., Sec. G, F. A. P. 121, 18 ft. in width, at $128,783.

Mass., Boston—State Hwy. Dept. let following contracts: Paving 6,600 ft. hwy, in Revere, 20 ft. and up, bitum. macadam, to M. McDonaugh, Swampscott, at $72,319; 3,652 ft. in Swansea, 18 ft. and up, rein. conc. to J. McCormick, E. Providence, R. I., at $15,641; 13,878 ft. in Haverhill, 20 ft. and up, rein. conc. to L. C. Carchia, 308 Bellevue St., W. Roxbury (Boston, P. O.) at $164,769.

Mich., Lansing—Following State Trunk Line contracts let: Rd. 65-1, D-1, Genesee Co., Fenton and Mundy Twps., Cl. G. & Ds, 0.380 mi. to Donaldson & Hull, Dryden, Mich., at $4,224; Rd. 38-7, A & B, Sanilac Co., Marlette Twp., Cl. F-Base, 20 & 26-40 ft. wide, 1.464 mi. to Murray & Fremont, Bad Axe, Mich., at $49,627; Rd. 38-7, A 7 B (est. cost cement, $12,202.28); 53-3, Sanilac Co. Marlette Twp., Cl. F-Base, 20 and 26,40 ft. wide, 0.582 mi., to Murray & Fremont, Bad Axe, Mich., at $18,953; (Rd. 53.3 Est. cost cement, $5,127.44); Rd. 12-15 B, Iron Co., City of Crystal Falls to Jno. Marsch, Inc., Chicago, Ill., at $9,492.

Minn., Red Wing—J. J. & M. S. Mergens, 400 Temple Court, Minneapolis, awarded contract for 5 mi. Job 2501, 93,553 cu. yds. excav., at $32,618, culverts, 478 cu. yds. conc., to Co. Palzer, Mazeppa, at $8,844; 2 mi. Job 2302, 43,950 c. y. excav. 1,200 ft. wooden pile and deck span brdg. to Campbell Constr. Co., 3050 Hennepin Ave., Minneapolis, at $23,454.

N. C., Greensboro—Murray, Constr. Co., Knoxville, Tenn., awarded contract to widen Greene St. 26 to 54 ft.; lay 12,500 sq. yds. sheet asph. on 6-in. conc. base, at $37,500.

N. C., Rutherfordton—Geer-Wilson Contg. Co., Rutherfordton, awarded contract for extending street paving; 8,000 sq. yds. conc., at $30,000.

N. C., Salisbury—R. G. Lassiter, Oxford, awarded contract for paving 30,000 sq. yds. various streets; sheet asphalt, Warrenite bitulithic and asph. conc., at $124,000.

N. Y., Brooklyn—Contract for paving Clarkson Ave., asph., to Borough Asphalt Co., 1301 Metropolitan Ave., at $32,001; repaving 2nd Ave., granite blk. to Leonard Paving Co., 233 Bway., New York, at $88,262; grading, curbing, flagging, paving and repaving, Sheepshead Bay, asph., to Cranford Co., 52 Ninth St., at $70,086.

N. Y., Long Island City—Contract for paving Buckley St., with granite blk., let to Welsh Bros. Const. Co., 32 Queens St., Astoria, at $13,984; 102nd St., sheet asph., to Borough Asphalt Co., 1301 Metropolitan Ave., Broklyn, at $54,700; grading sidewalk space and gutters in Caffrey Ave., to R. A. Hess, Inc., 14 Queens St., Astoria, at $2,660; grading, curbing, recurbing, flagging and reflagging, etc., 102nd St. ,to J. J. O'Brien, Jr., William St., at Jamaica, at $18,124.

N. Y., New York—Casper Helbock, Inc. Harlem River and 150th St. awarded contract by J. Miller, Pres. Manhattan Boro., for grading, curbing, flagging, reflagging and granite block paving on W. 155th St., at $100,555.

N. Y., St. George—Following contracts let by J. A. Lynch, Pres. Richmond Boro.; Repaving Richmond Turnpike, granite blk., to C. Vanderbilt, Elizabeth St., West New Brighton, at $27,630; paving Center and Moore Sts., conc., also Gifford Lane, bituminous macadam, to J. Johnson, Sons, 455 Broadway W. New Brighton, at $20,960 and $33,774, respectively.

Nev., Carson City.—State Hwy. Comn., let contracts for grading and gravel surfacing on 11.81 mi. bet. Eastgate and East Co. line (Carroll Summit) F. A. P. 56; 2-F Contr. 93, Churchill Co. to F. Coolidge, Laramie, Wyo., at $173,147; grading and bldge. culverts on 3.35 mi. rd. from Lowton to 2 mi. east of Verdi, F. A. P. 73, 1-a-2, Contr. 94, Washoe Co., to C. Miles, 2,500 L Street, Sacramento, at $74,695.

Ohio, Akron—T. E. McShaffrey Constr. Co., 171 S. Forge St., awarded contract for improving N. Main St., at total cost of $158,808. 26,000 c. y. grading $0.69 per c. y.; 3,400 sq. yds. brick gutter, asph. filler, $2.35; 16,800 sq. yds. asph., Willite pavement Pian B. Trinidad, $1.85, etc.

Ohio, Columbus—Dept. Hwys. & Pub. Wks., let contracts for grading, bridging and paving 2.821 mi. Sec. "B", 2,825 mi. Sec. "E" and 0.521 mi. Sec. "Ohio City" Van Wert-Rockford Rd. Van Wert Co., 1st 2 sects. bitum. macadam, asphalt and latter rein. conc. to Putnam and Shindeldecker Van Wert, at $60,933, $57,147 and $11,803, respectively.

Ohio, Marion—H. P. Streicher, Marion, awarded contract for improving with sheet asph. 1 mile Sec. 1, George St., at $25,474; 1½ mi. Sec. 3, George St., at $37,750; ½ to ¼ mi. Sec. 2, George St., at $25,943; Thew Ave., $28,182; Wilson Ave., $28,440, all 40 ft.

Pa., Pittsburgh—Booth & Flinn, Ltd., 1942 Forbes St., awarded contract for paving Manchester Ave., at $92,776; Bennett St., to M. O'Herron Co., So. 1st and McKean Sts., at $41,730; Flotilla Way and to M. Mannella, 5140 Breedshill St., at $11,526.

S. C., Aiken—J. L. Carroll, Columbia, S. C., awarded contract for 11,407 ml., State Rte. 28 from Sandbar Ferry bridge to Ellenton, at $40,086.

S. C., Batesburg—Carolina Contg. Co., Spartanburg, awarded contr. for paving 20,000 sq. yds. various sheet with sheet asph., at $55,000.

S. C., Spartanburg—Southern Paving & Construction Co., Spartanburg, awarded contract for 4.296 miles hard surface rd. on State Hwy. No. 8—City limits towards Converse and Cowpens, at $134,454.

S. C., Walhalla—F. M. Deaver, Carlisle, awarded contract for top-soil surfacing 6.4 miles State Rte. 18, F. A. P. 225 at $25,926; bridge work to Southern Concrete Constr. Co., Anderson, S. C. at $5,334.

S. D., Pierre—W. R. Larson, 519 Second, National Bank Bldg., Sioux Falls, awarded contract for gravel and rock surfacing 12 miles highway from Elk Point to Sioux City, at $57,000.

Tex., Amarillo—Hoffman Constr. Co., Eastland, awarded contract by Potter Co. for grading and gravel surfacing 6.13 mi. Bushland Rd., State Hwy. 12, State Aid Proj. 430, 16 ft., at $49,517.

Tex., Center—Brammer & Wilder, 308 Stewart Bldg., Houston, awarded contract for hard surfacing various sts., at $2.65 per yard. Total, $122,847.

Tex., Dallas—Smith Bros., Inc., Sumpter Bldg., awarded contract by Dallas Co. for paving, etc., 12.7 mi. Richardson Rds., at $1.10 paving, conc. base, $1.65, etc. Total, $530,000.

Tex., Jasper—R. B. Sparks, Gaston Bldg., Dallas, awarded contr. for 3 roads as follows in Jasper County: Construct drainage structs. and gravel surf. on 6.2 mi. State Hwy. No. 7, F. A. P. No. 82, at $47,352; gravel surf. 4.2 mi. State Hwy 63, State Aid Proj. 93, at $9,381; gravel surf. 1.55 mi. State Hwy. No. 7, State Aid Proj. 421.

Tex., Jefferson — Womack Construction Co.,

Sherman, awarded contr. by Marion County for grading, gravel surfacing, etc., 14.42 miles State Hwy. 49, F. A. P. 364, 16 ft., at $108,419; 34,716 c. y. gravel to be furnished by County. Engr's est., $148,600.

Tex., Vernon—J. P. Foty, Vernon, awarded contract by Wilbarger County for 3.62 miles 18-ft. conc. road at $105,608.27.

Wash., Lind—W. J. Doust, Spokane, awarded contract by Board Co. Commrs., for constr. of 9½ mi. Cunningham-Othello Rd., at $67,000.

Wash., Olympia—M. A. Degerstrom, Payton Bldg., Spokane, Wash., awarded contract to grade, drain and surface with gravel 2½ miles State Rd. No. 4 from Wilbur Hill to Clark in Lincoln Co., at $36,975.

Wash., Seattle—Coluccio & Erickson, Thompson Bldg., Seattle, awarded contracts by Bd. Pub. Wks. for installing water mains and fire hydrants in 34th St., et al, at $46,193.

Wash., Tacoma — Warren Construction Co., awarded contract for paving Center St., at $56,881.

SEWERAGE AND SEWAGE TREATMENT

Ark., Hot Springs—E. B. Mooney, 348 Valley St., awarded contract for 10,400 ft. 24-in. sewer, etc., at $41,000.

Cal., Alhambra—Hickey & Harmon, 1501 Mission St., awarded contr. for 52,956 lin. ft. 8-in. vit. sewer, 1,491 house connections, etc., in Dists. 3 and 5, at $62,387 and $74,385, respectively.

Cal., Santa Paula—Cox & Tegert, 615 Olive St., Alhambra, awarded contract for conc. septic tank for sewerage system at $16,300; 3 miles 6-20 in. conc. pipe to Bent Concrete Pipe Co., Security Bldg., Los Angeles, at $9,025.

Que., Montreal—C. Frascareli, 654 Berri St., awarded contract for constr. of 930 ft. 2x3 brick sewer and 2,100 ft. 12-in. tile sewer in Sherbrooke St., Wurtels to Bourbonniere St., at $38,245.

Man., Portage La Prairie—Fowler, Young & Holden Co., Ltd., Winnipeg, awarded contract for outfall sewer at $77,475.

Conn., Meriden—Suzio Constr. Co., State St., awarded contract for laying 8-20 in. sewers in various streets. Engrs. est., $33,000.

Ga., Columbus—Columbus Constr. Co. awarded contract to construct Cook branch sewer at $37,463.

Ky., Louisville—H. Bickel, 443 Garden St., awarded contract for constr. of Dry Run Relief Drain, 1,200 ft. 9 ft. and 258 ft. 8-6 in. semi-elliptical and special structs., at $133,723.

La., Ponchatoula—Following contracts let for sewer pipe and constructing manholes, etc., as follows: Nat'l. Cast Iron Pipe Co., Tarrant City, Birmingham, Ala., at $19,831; disposal plant to Hayden Constr. Co., Pass Christian, Miss., at $29,500; furnishing vit. clay pipe to Southern Sewer Pipe Co., 28th Ave. N. Birmingham, Ala., at $11,500.

Mo., University—(St. Louis, P. O.)—Frazier-Davis Constr. Co., Arcade Bldg., St. Louis, awarded contract for about 4,000 ft. 8-36 in. storm and san. sewers, etc., in Univ. Hills sub-division. Engineer's est., $35,000. Myers Constr. Co., Merchant Laclede Bldg., St. Louis, awarded contract for 3,400 ft. 10-36 in. vit. sewers, etc., in Kingsland Ave., Dists. 31 and 35 in University, Mo., at $29,000.

Minn., Winona—Sewers in Dist. 4, 7,529 ft. 12-18 in. vit. clay pipe, 45,429 lin. ft. 6 and 8 inch stand. vit. clay pipe, 156 brick manholes, to W. Fraser & Son, 810 Guardian Life Bldg., St. Paul, at $93,301.

N. J., Newark—O'Gara Constr. Co., 242 Market St., awarded contract for construction at sedimentation section of Passaic Valley sewerage.

N. J., Plainfield—Cocuzzo & De Cicco, Hilton, awarded contract for storm sewers in portions of E. Front St. and Northwood Ave., at $30,885.

N. J., Trenton—J. Cifelli, Fair street, awarded contract for concrete sewer in Remsen St., also 8-in. drains in DeKlyn and Cortlandt Sts., at $31,100.

Ohio, Cleveland—Duff & O. H. Champion, 1471 Arthur Ave., Lakewood, awarded contract for 2,700 ft. 8-27 in. vit. clay and 725 ft. 33 in. segmental blk. sewer in Snow Rd. Impvt. 39, at $38,386.

Tex., Clarksville—Mitchell Constr. Co. Carter Bldg., Houston, awarded contract for Imhoff tank disposal plant and sewers, at $36,000.

Tex., Laredo—Kirkwood & Wharton, 231 W. Commerce St., San Antonia, awarded contract for storm sewer system, pre-cast mains and laterals, at $83,040.

Wis., Milwaukee—Hammen & Co., 516 Garfield Bldg., Detroit, Mich., awarded contract by Sewerage Comm., for rein. conc. pipe, Cambridge and Brady Sts., to Cambridge and Concord Sts., at $575,187.

WATER SUPPLY AND PURIFICATION.

Cal., Long Beach—U. S. Cast Iron Pipe & Fdry. Co., Wright and Calendar Bldg., Los Angeles, awarded contract by City for 6, 8 and 12 in. cast iron pipe at $227,215.

Cal., Santa Barbara—S. Hunter, 122 W. Valerio St., awarded contr. for 12-in. cast iron mains in Cliff Dr., and 8-in. main in portion of Mesa School Lane, at $37,110.

Ont., Toronto—Francis Hankin & Co., Ltd., 386 King St. W., awarded contract for iron pipe at $228,219.75.

Colo., Denver—Rensselaer Valve Co., 53 W. Jackson Blvd., Chicago, awarded contract for vertical valves—4-48 in., at $69,895.

La., Crowley—McIntosh Bros., Okla. City, Okla., awarded contract for installing mains, conc. reservoir, fire hydrants, pumps, also sewers, and grading and paving streets, at $108,000.

Miss., Moorehead—C. P. Sledge, Abbeville, La., awarded contract for water works plant, 100,000 gal. tank, 4, 6, and 8-inch pipe, two 500 g.p.m. pumps, at $50,000.

Mo., Joplin—W. R. McCormick, 1801 Sergeant St., awarded contr. for water works extensions at $30,000.

N. Y., Long Island City—Dallo, 203 Division St., Brooklyn, awarded contract for reconstr. of pumping station in Camp Rd., etc., at $36,987.

O., Cleveland—P. F. Connolly, E. 102nd St., nr. Euclid Ave., awarded contract for concrete tunnel to Fairmount Rd. for Baldwin-Fairmount Proj. Contr. 43; 1,017 c. y. concrete, at $140,000.

Ohio, Troy—J. E. Nelson & Sons, 3240 S. Michigan Ave., Chicago, awarded contract by Baltimore & Ohio R. R. Merchants Loan & Tr. Bldg., Chicago, for water treating plant here, at cost to exceed $25,000; also contract to same contractors for water treating plant at cost to exceed $25,000 at Lima, Ohio.

Pa., Glassmere—Dravo Contg. Co., Diamond Bldg., Pittsburgh, awarded contract for intake well, herd. Engrs' est., $25,000.

La., Ponchatoula—Town let following contracts for water works and sewer impvts.: Chicago Bridge & Iron Co., Chicago, Ill., at $5,185 for elev. tank and tower; Chambers & Bowers, Hammond, La., at $17,000 for reservoir, machinery, foundations, house, laying cast iron pipe; at $17,300 for laying sewer pipe and at $2,200 for constructing manholes; National Cast Iron Pipe Co., Birmingham, Ala., at $19,833 for cast iron pipe; Dixie Mill Supply Co., 901 Tchoupitoulas St., New Orleans, La., at $4,221 for steel pipe, hydrants and boxes and at $2100 for 10-in. wood stave pipe; Grey Artesian Well Co. for wells; Hayden Constr. Co., Pass Christian, Miss., at $29,500 for sewage disposal plant and miscel. excav.; Southern Sewer Pipe Co. Birmingham, Ala., at $11,500 for vit. clay pipe. Contract for pumping machy. not let.

Neb., Fremont—Following contracts let: Turbo-Generator, Condenser, to Allis-Chalmers Mfg. Co., 321 N. 8th St., Lincoln, at $29,260; Pumps, meters, to Worthington Pump Co., at $7,850.

N. J., Woodbury—Contract for cast iron pipe let to U. S. Cast Iron Pipe Co., 1421 Chestnut St., Philadelphia, at $35,987; castings, etc., to Rensselaer Valve Co., 50 Church St., New York City.

Tex., Dallas—R. J. Estep & Co., and Pittsburgh-Des Moines Steel Co., Praetorian Bldg., Dallas, awarded contract for 20,000 ft. mains in Midway Rd. and Lover's Lane; steel tank and tower; $25,000.

Wash., Seattle—Coluccio & Erickson, Thompson Bldg., Seattle, awarded contract for installing water mains and fire hydrants in 34th Ave. so et al, at $46,193.

Wis., Appleton—C. R. Meyer & Sons Co., 50 State St., Oshkosh (sub-let) have general contract for filter plant; reinfg., to Richard S. Hill, Milwaukee. Brk. probably will be purchased here; cement, sand and gravel locally. $30,000. Owners. Riverside Fiber & Paper Co., Govt. Canal, Appleton.

Prospective Work

ROADS AND STREETS.

Ark., Little Rock—Pulaski County plans expending $3,300,000 to construct 95 miles highways, including 57 miles primary, 10.5 miles secondary and 28 miles state roads. G. H. Sykes, 6th Dist. Engr.

Conn., Hartford—Street Dept., Municipal Bldg., plans to purchase snow loader, similar to Barber-Greene type, $6,000; set of bucket loaders to be attached to various equipments, $2,000 each; catch-basin cleaner; scarifier road roller.

Fla., Sarasota—Election Jan. 29th to vote on $590,000 bonds for road bldg. in Sarasota County as follows: Rd. sys. on mainland, $500,000; road down the Keys and 2 bridges across Sarasota Bay from mainland to Key, $90,000.

Ia., Indianola—Petition being circulated to pave 22 blocks. E. M. Wilson, City Clk.

Ia., Shenandoah—Resolution passed for 48 blocks additional paving on various streets. Work will be started in Spring. J. E. Lewis, City Clk.

Ky., Frankfort—State Hwy. Dept., plans to improve roads as follows: Barron Co., grade and constr. draining, structs. on 11.4 mi. Glasgow-Burksville rd. from east corp. limits of Glasgow to Metcalf Co. line, State Proj. 40, Sec. A; Metcalf Co. grade and drain 12 mi. Glasgow-Burksville rd. from Barren Co. line to Cumberland Co. line, St. Proj. 40, Sec. A; Cumberland Co., grade and drain 2.2 mi. Glasgow-Burksville rd. from Metcalf Co., to Ferris Creek; State Proj. 40, Sec. A; Cumberland Co., 12.7 mi. gravel, waterbound or macad. or waterbound macad. surf. treated Glasgow-Burksville rd. from Ferris Crk. to Burksville; State Proj. No. 40, Sec. A. Joe S. Boggs, State Hwy. Engr.

Ky., Hickman—Fulton County plans 32 miles 18-ft. conc. rd. from State line in lower end of County through Hickman to Fulton. Est. cost, $1,200,000. Will Vote in January on $550,000 bonds.

Minn., Moorhead—Clay County will gravel road No. 6 (abt. 24 miles); rd. No. 64 (abt. 25 miles) next year. County will be bonded for $250,000. A. O. Houglum, Co. Aud.

Mont., Harlem—Revising survey made for state hwy. across the Ft. Belknap reservation from Harlem to Dodson to be built next year. About 29 miles State Hwy. E. J. Dorreen, Engr. Surveys made for rd. from Babb to Canadian line to connect with rd. from Cardston.

N. C., Bridgeton—Town considering paving streets and improving walks. $212,000 voted for purpose. Address Board of Aldermen.

N. C., Dobson—Surry County Commrs. considering constr. of 5-mile road from Kapp's Mills to Lowgap, thru Thurmond.

N. D., Valley City—Barnes County contemplates gravel trail from Magnolia west to County line in Spring, 300,000 cu. yds. gravel. Chas. W. Nelson, Anditor.

Okla., Bartlesville—Washington County will let contract to constr. rd. from Ramona to Vera and to south County line, connecting with highway in Tulsa Co. Est. cost, $200,000; Fed. Aid, $100,000.

Okla., Sapulpa—Creek Co. Commrs., plan hard surfacing roads totaling 63 miles as follows: 11½ mi. Albert Pike 33 mi. Ozark Trail from Sapulpa thru Bristow and Depew to point 2 miles from Lincoln Co. line; 12 miles to so. limits of Mounds; 6 miles from Shamrock to Drumright. Election in January to vote on $700,000 bonds.

Portland, Ore.—Report of City Engr. for proposed extension and widening of Burnside and Glison Sts., filed with City Aud. Est. cost of project, $2,548,165.

S. C., Conway—City plans to expend $160,000 to pave about 1½ miles, including Main, Laurel, 3rd, 4th and 5th Sts. U. S. Suggs, Mayor; Ryan Engrg. Co., Columbia, Co. Engrs.

S. D., Pierre—Plans under way for graveling Custer Battlefield highway from Sioux Falls to Black Hills; also constructing Sunshine highway.

S. D., Sioux Falls—It is planned to construct road in Minnehaha Co., from Hudson Bay, Canada, to Los Angeles, Cal., via Duluth, Twin Cities, Minn., Sioux Falls, Wheeler, S. D., Denver, Salt Lake City, U. S. G.. Cherry, Atty, Sioux Falls, interested.

Tex., Del Rio—Val Verde County will receive bids in about 30 days for 12.74 mi. gravel road from intersect. with Rock Springs Rd. G. M. Jowers Co., Engr.; W. F. Littleton, Co. Judge.

Tex., Kaufman—Kaufman County will let contract in Spring to lay waterbound macadam with asphalt top on road from Kaufman to Dallas Co. line. Est. cost, $160,000. B. F. Williams, Co. Engr.; W. P. Williams, Co. Judge.

Tex., Port Arthur—City contemplates making municipal impvts., as follows. Voted $1,036,593 bonds: Asph. pavements and storm sewers, $297,937; shell and gravel paving, $169,960; improvement of Shrevepart Ave., and cover open drainage ditch, $69,449; park impvts., $19,825; fire dept., $56,500; new pumping units for increased water extensions, $91,262; incinerator, $45,000; breakwater and boat landing at pleasure pier, $6,125; repair and improve city slip, $9,000; extend water lines, $119,447; san. sewer line, $132,633. J. P. Logan, Mayor.

Wash., Raymond—Citizens are petitioning for bldg. of rd. from McGowan to Knapston (which would be virtually an exten. of Ocean Beach hwy. some 7 miles).

Wash., Seattle—Bids will be called within 30 days for paving 2 miles of Kent-Des Moines rd. east from Des Moines over the hill and into the valley to Kent. Proj. approved by King County Commrs. Bd. Thos. R. Beeman, King Co. Engr. New conc. pavement will be 20 ft. in width and will run from Des Moines to new state line crossing. Surf. will be 7 ins. in thickness of new stand. type. Est. cost $60,000.

Wis., Pt. Washington—Ozaukee County Board appropriated $255,000 for constr. of 8 miles conc. road from Milwaukee Co. line on Hwy. 57 to no. end of City of Cedarburg; also $100,000 for graveling roads thru Thiensville, Belgium, Lake Church, Holy Cross, Waubeka and Decada, connecting with trunk Hwys. 57 and 17. J. Ubbink, Commr.

Wisconsin—Pt. Washington: Ozaukee Co voted $350,000 bond issue for highway work; 8 miles to be paved with conc. bet. Milwaukee-Ozaukee Co. lines on Hwy. 57, $255,000. Will gravel 23 miles to connect Theinville, Belgium, Lake Church, Holy Cross, Waubeka, etc., with highways 57-17. $100,000 Jno. Bichler, Co. Clk. Whitehall: Trempeleau Co. Bd. approp. $194,747 for road constr. during 1924; also $7,000 for road machinery, including patrol road graders, etc. E. F. Rotering, Arcadia, Commr. Fond du Lac: Fond du Lac Co., approp. $699,619 for rd. constr. during 1924. Geo. Treleven, Commr. Stevens Point: Portage Co. Bd. approp. $71,590 for road constr. during 1924; also $2,000 for small tools, graders, scrapers and wheelers, etc. T. S. Cauley, Commr. Wautoma: Waushara Co. Bd. voted road constr. program for 1924 amounting to $34,174; also $6,000 for purch. of road machinery, including gravel crushing machy., graders, drags and other equipt. Fred Grimm, Commr. Menomonie: Dunn Co. voted rd. constr. program amounting to $88,896 for 1924; also $9,000 for purch. of rd. machinery, including patrol graders. Frank Stewart, Commr. Durand: Pepin Co. approp. $50,221 for rd. constr. during 1924; also $4,000 for purch. of rd. machy. Gale Goss, Commr. Friendship: Adams Co Bd. approp. $25,097 for rd. constr.; and $4,000 for purch. of rd. machinery. J. A. McGregor, Commr. Phillips: Price Col. Bd. voted $87,791 for rd. constr. during 1924 and $14,400 for purch. of rd. machy, including crusher and patrol graders. B. M. Griffin, Commr. Oconto: Oconto Co. voted $138,247 for rd. constr., and $5,000 for purch. of rd. machinery, $8,000 for crushing plant and $5,000 for machine shop. E. W. McAllister, Commr. Medford: Taylor Co. Bd. voted $100,000 bonds for constr. of gravel rds. in Taylor Co. C. Kolnhofer, Commr. Portage: Columbia Co. Board voted $50,000 for fed. aid proj. on Trunk Hwy. 29. This sum will be met by State with $150,000, being State and Fed. aid making in all $200,000 available. J. T. Henton, Commr. Fond du Lac: Co. Bd. voted $874,800 for rd. constr. program for 1924 amounting to $874,800. Geo. Treleven, Commr. Green Bay: Brown Co. voted road constr. program amounting to $511,360 during 1924. Geo. J. Cormier, Commr. Sparta, Wis., Monroe Co. approp. $7,000 for rd. machy., including 19 patrol outfits; also $368,206 for rd. constr. during 1924.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Chas. Millard, Commr. Neillsville: Clark Co. ap. prop. $125,261 for rd. constr. during 1924 also $10,000 for purch. of rd. machy. O. J. Weymiller, Commr. Merrill: Lincoln Co. approp. $141,300 for rd. constr. during 1924 and $8,000 for purch. of rd. machy. H. H. Kuehling, Commr. Baraboo: Sauk Co. approp. $194,613 for rd. constr. and sufficient money to purch. small graders, small rock crusher and power unit. Wm. Halbersleben, Commr. Portage: Columbia Co. Bd. voted $50,000 for completion of Hwy. 29 bet. Portage, Kilbourn and the Wisc. Dells. J. T. Henton, Co. Hwy. Commr. Court House.

SEWERAGE AND SEWAGE TREATMENT

Ala., Fairfield—Board of Revenue approved floating of $1,000,000 bond issue to take care of sewerage situation in Jefferson County to serve Possum Valley and to connect with County trunk sewer between Fairfield and Bessemer.

Cal., Elsinore—Prelim. plans and ests. completed for sewer improvements. Est. cost $28,000. Bond elec. will be called soon. Burns & McDonnell Engrg. Co., 413 Marsh-Strong Bldg., Los Angeles.

Cal., Glendale—Prelim. plans and ests. completed and election will be held to vote on $1,600,000 for san. sewers here. Burns & McDonnell Engrg. Co., Los Angeles, Cons. Engrs.

Cal., La Verne—Election may be held to vote on $65,000 bond issue for sewerage system. Cons. Engrs. Black and Veatch, Fay Bldg., Los Angeles.

Pismo Beach, Cal.—City will vote on $33,500 bonds for disposal plant; 1,200 ft. cast iron outfall sewer and septic tank. Black & Veatch, Fay Bldg., Los Angeles, Cons. Engrs.

Cal., So. San Francisco—City considering constructing sewers in San Bruno Rd. and portions of Butler Rd., etc. G. A. Kneese, care Court House, Redwood City, Cons. Engr.

Cal., Whittier—Citizens will vote on $50,000 bonds for purpose of completing disposal plant here. Cons. Engrs. Black & Veatch, Fay Bldg., Los Angeles.

Ont., Hamilton—Election will be held in January to vote on $890,000 bonds for sewage disposal and storm overflow system. W. L. McFaul, City Hall, Engr.

Man., Headingly—A. Melville, 5 National Trust Bldg., Winnipeg, preparing plans for sewage disposal system here. J. Kenaston, Minneapolis, Minn., is owner.

Ont., North Bay—Bids will soon be taken here for 9,500 ft. 6-12 in. vit. tile san. and storm sewers Est. cost $40,000. W. Mackie, Twn. Engr.

Ont., Toronto—City considering constr. of 13,000 ft. vit. tile storm & san. sewers, 8-in. up, in various thoroughfares at cost of $48,550. R. C. Harris, City Engr. York Twp. (Toronto) plans 7,000 lin. ft. 12-in. vit. tile sewer in Governors' Rd. Nesbitt Dr. and Douglas Crescent to disposal plant at Pottery Rd. $36,000; also 6,000 ft. 12-in. vit. san. sewers at cost of $25,000. F. B. Goldike, 4 Jarvis, St. Engr.

Ont., Windsor—Plans being prepared for sewers in Campbell Ave., probably 8-in. pipe. $30,000. Prices desired on materials. M. E. Brian, City Engr.

Ga., Albany—City will probably vote on $100,000 bond issue for sewerage and drainage.

Ind., Seymour—Chas. L. Kessler, Mayor, and L. E. Jennings, Clk.-Treas., have been authorized by City Council to enter into contract with Chas. H. Hurd, San., Engr., Indianapolis, to complete plans and specifications for new sewerage system in Seymour, Prelim. survey completed. Approx. cost of sys., $240,000.

Ia, Council Bluffs—Work will soon start on repairing 6th St. sewer, and relaying 6 blocks of sewers, etc., at cost of $140,000. O. Hochman, City Clk.

Miss., Chisholm—City considering building new, or remodeling old, sewage disp. plant. Ernest Drew, City Clk.

Minn., Harmony—Louis P. Wolff, 1,000 Guardian Life Bldg., St. Paul, has made plans for complete sewer system (sanitary). Problem mature in 1924. T. Sanderson, Jr., Vil. Clk.

Minn., Willmar—City making plans for complete san. and storm sewerage system, remodeling present system and installing new treatment plant with pump, filter beds, etc., Est. cost $100,000. Claussen & Carroll, 406 Metropolitan Bank Bldg., St. Paul, Cons. Engrs.

Ohio, Ashtabula—Bids will be advertised for after Feb. 1st for sewage treatment works; also 4,200 ft. 42-in. segmental block submerged outfall pipe. Est. cost, $100,000. G. B. Gascoigne, 648 Leader-News Bldg., Cleveland, Engr.

Ohio, Toledo—$490,000 bonds voted for completion of intercepting sewerage system, constructing sewage pumping station and disposal plant. A. Jackson, City Bldg. Direct. Pub. Serv.

Tenn., Union City—Bonds voted and sold to amt. of $40,000 for extensions to sewerage system here. C. H. Jenks, Union City, preparing plans for the impvt. Bids will be received in January. S. J. Woosley, Mayor.

Tex., Alvin—Plans being made for disposal plant and sewers. Est. cost $25,000. Municipal Engrg. Co., Praetorian Bldg., Dallas, Cons. Engrs.

Tex., Dallas—Meyers & Noyes, Cons. Engrs., making survey for sewer line to serve territory at end of No. Henderson Ave.

Tex., Dallas—Park Board has accepted proposition of N. Texas Trust Co., for development of 73 acres in northwestern sect. of Oak Cliff for park; will expend about $30,000 in impvts., including extension of city sewer system, waterworks, elec. lights; bldg. of 9-hole golf course, etc., etc.

Tex., Floyada—City considering erection for purpose of voting on approx. $25,000 bonds for completion of sewerage system. C. Baker, 1st National Bank Bldg., Okla. City, Okla. Cons. Engr.

Utah, Salt Lake City—City plans 4 miles 2-6 ft. 14th St. so. from 11th St. E. to Jordan River. Est. cost $250,000. C. Cannon, City Engr.

Wash., Seattle—Ord. introduced at Council meeting proposing treatment of sewage before it reaches Lake Washington. Bill appropriates $85,000 and provides for constr. of sewage disp. plants at or near Rainier Ave. and Perry St., Mass. St. and Lakeside Ave. so., Alaska St. and 54th Ave. so.; Juneau St. at Lake Washington and 45th Ave. so. and Charles St. Similar plants will be provided for sewers leading into Lake Union and Union Bay as means of purifying waters of fresh water lakes lying within city limits. Constr. of perm. sewer outfall in 11th Ave. N. W. at total cost of $65,000; provided for in bill introduced and referred to Streets & Sewers & Finance Committees.

Wis., Centuria—Town contemplates constructing san. sewerage system to cost about $25,000. Cons. Engrs., Druer & Millinowski, Globe Bldg., St. Paul, Minn.

WATER SUPPLY AND PURIFICATION.

Cal., Eureka—City plans to purchase 5,800 ft. 12-in. water pipe. H. Hannah, City Engr.

Cal., Oakland—East Bay Water Co., 512 16th St., making plans for Upper San Leandro Creek storage reservoir.

Cal., San Francisco—Prelim. plans being made for storage dam in Pacoima Creek, 100 ft. high, 160 ft. long on top, 60 ft. long on bottom and 16,700 lin. ft. 14-in. riveted steel pipe line, etc. $75,000.

Cal., Santa Barbara—Plans being prepared for the Montecito Water Co. Water Dist., for 6,000 ft. 7x8 ft. tunnel thru Santa Ynez mountain at Toro Canyon; also conc. dam 135 ft. high, 300 ft. long on top and 50 ft. at bottom. Leeds & Barnard, Central Bldg., Los Angeles, Cal., Cons. Engrs.

Cal., Santa Monica,—City will vote on $1,000,000 bonds for addns., and extensions to water system. Olmsted & Gillelen, Hollingsworth Bldg., Los Angeles, Engrs.

Cal., Swartsville—Excelsior Water & Power Co. plans erection of multiple arch conc. dam on Deer Creek; 100 to 166 ft. high. Penstock and power house will be built by day labor.

Cal., Stockton—Plans being made by T. J. Locke, care Case & Forslund, attys., Commercial Savings Bldg., for installation of 2 10-in. centrif. pumps, operated by two 20 h.p., 1,200 r.p.m., 440 volt motors, to replace existing 12-in. pump. R. G. Clifford, 2130 23rd St., Sacramento ,Cons. Engrs.

Cal., Walsenburg—$35,000 bonds issued for improving water system.

Ont., Belleville—City contemplates erecting new pumphouse to include 3,000,000-gal. contrifugal pump and motor. Est. cost, $35,000.

Ont., Neustadt—Town contemplates constructing

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

water works system. Estimates being secured. Est. cost, $50,000.

Fla., Lakeland—City will expend $150,000 for installation at two 2,000 g.p.m. contrif. pumps and extension of cement and brick bldg., daily capy. 5,760,000 gals.; 4, 6, 8 and 10-in. cast iron water main. Chas. Larsen, Supt. Light & Water Dept.

Fla., Sanford—City will vote on $800,000 bonds for water, gas and electric light plants.

Ill., Orlando—Prelim. plans being made for water works pumping plant, tower, distribution mains, etc. $25,000. E. Hancock, 2047 Ogden Ave. Chicago, Cons. Engr.

Ind., Farmersburg—City considering constr. of water works and pumping station at cost of $40,000. Engineer not announced.

Minn., St. Paul—Council has authorized bond issue in sum of $500,000; funds to be used for water works impvts. in 1924. J. W. Kelsey, Supt. Water Dept.

Minn., St. Paul—City plans steel tank for Water Dept. Est. cost, $19,000.

Miss., Meridian—City considering voting on $80,000 bonds for improvement of water system.

Mo., Cameron—Prelim. plans being made for water works and light impvts. $15,000. Burns & McDonnell Engrg. Co., 401 Interstate Bldg., Kans. City, Cons. Engineers.

Mo., Boonville—City contemplates purchasing 350 g.p.m. motor driven pump for water works. C. H. Miller, City Clerk.

Mo., Festus—Town will soon receive bids for water works and san. sewerage systems. $175,000 bonds voted. J. P. Davis, Jefferson City, Engr.

Md., Hagerstown—City contemplates enlarging water works system by construction of pumping plant on Potomac River near Williamsport, Md.

Mo., Hannibal—$400,000 bonds voted for new pumps and motors, filtration plant, high service reservoir and new mains, etc. D. H. Maury, 304 S. Dearborn Street, Chicago, Cons. Engr.

Mo., La Plata—Election planned for Spring to vote on $90,000 water works impvts. and sewerage system.

Mo., Piedmont—City will vote on $40,000 bonds for water works system. For detailed information address the Mayor.

Mo., Springfield—Springfield Water Co. will expend about $300,000 for impvts. during next 3 years.

N. J., Asbury Park—City plans extensions and additions to water system, including fittings, valves, hydrants, etc. Est. cost, $17,000. R. Bartley, Jr., Asbury Park, Engr.

N. Y., Ballston Spa—$325,000 bonds voted for Crook Brook Water supply, including reservoir, pipe lines, valve houses, etc.—1,800,000 gal. daily capy.

N. Y., Elmira—City of Elmira plans to construct water system in Southport at cost of $20,000. Engineer not yet announced. Plans will mature in Spring.

N. Y., La Salle—City considering 100,000 gal. standpipe on Point Ave. Est. cost $24,000. Will mature in Spring.

N. Y., Schenectady—Common Council has authorized purchase of new 60-cycle pumping apparatus to produce 12,000,000 gals. every 24 hrs., for the Rotterdam water station.

N. C., Conover—Plans being made and bids will be advertised for within 30 days for water and sewerage systems. Cons. Engrs., Spoon & Lewis, Greensboro.

Durham, N. C.—City planning to extend water line to the Albright section.

N. C., No. Wilkesboro—Bids will be received here about January 15, 1924, for water filtration plant; also oil engine generator station complete with all necessary appurtenances. Carolina Engineering Co., 412 Southern Bldg., Wilmington, N. C., Cons. Engrs.

Ohio, Barberton—Council has approved $779,687 bonds for 600 m.g. reservoir covering 600 acres, waters to be stored up by 400 ft. dam. 200 ft. wide, 30 ft. high, etc., in Wolf Creek Valley. Spillway 150 ft. wide will be feature of dam. Total cost, $1,000,000.

Ohio, Findlay—City considering expendt. of approx. $1,000,000 for repairing water works system.

Ohio, Lima—It is proposed to enlarge present water plant. Est. cost, $100,000. W. H. F. Dittoe, Columbus, Engr.

Ohio, Marietta—City considering constr. of elevated tank, booster station and 1½ miles of mains. Est. cost abt. $30,000. C. A. Stone, City Engr.

Ohio, Middletown—Plans under way for constr. of new water works and pumping plant. Est. cost, $42,000.

Ohio, Mt. Sterling—Town plans to rebuild water works, recently destroyed by fire.

Okla., Heavener—Surveys being made for dam, storage reservoir filter plant, pipe lines and machinery. $100,000. V. V. Long & Co., 1300 Colcord Bldg., Okla. City Cons. Engrs.

Okla. City Okla.—$1,600,000 bonds voted here for 350 ft. extension to main dam, new control works, bank widening and gates for control, 60,000 concrete, 150,000 excavation. B. M. Hart, City Hall, Engr.

S. C., Aiken—Commrs. Pub. Wks. will erect standpipe or tank and tower with capy. of 500,000 gals. H. Sudlow, Supt.

S. C., Florence—$350,000 bonds voted for extension of water, sewer and drainage systems.

S. C., Inman—$50,000 voted for water works and $50,000 bonds for sewers.

Tenn., Knoxville—Citizens Committee has recommended constr. of entirely new water plant, combing pumping sta. and filtration plant at mouth of Williams Creek; also immense reservoir located on eminence at Hale's Orchard. Will recommend, also, that $2,000,000 bonds be issued.

Tenn., Union City—C. H. Jenks, Union City, preparing plans for additions to water works plant amounting to approx. $90,000. Bond issue voted recently to cover cost of project. Bids will be received in January for the impvt.

Tenn., Watertown—City plans to construct new water plant, to be operated electrically and to cost approx. $50,000.

Tex., Austin—$850,000 bonds voted, including $300,000 for filtration, $500,000 school and $50,000 for incinerator. M. D. Yett, Mayor.

Tex., Crosbyton—$22,000 bonds voted for mains and equipment. Baker & Von Zuben, Ellison Bldg., Ft. Worth, Cons. Engrs.

Tex., San Antonio—Water Company contemplates constr. of 20 m.g. covered conc. reservoir, sinking 3 new artesian wells and laying 42-in. main from main pumping plant to northern portion of city. Est. cost, $800,000; also laying additional mains in new and suburban addns., to city at cost of $150,000.

Wash., Centralia—City Council considering installing auxiliary pumping and filtration plant on Skookumchuck River, 1,500,000 g.p.d. capy., (ultimately 6 m.g.p.d.). Est. cost, $40,000. N. W. Avery, Centralia, Engr.

Wash., Lynden—Town considering constr. of filtration plant at Nooksack River, including new steel tower and tank, filtering plant, chlorine plant and impvts., at intake. Est. cost, $35,000.

Wash., Wapato—City Council has decided to call bids for material for impvt. of city water system. Abt. 18,000 ft. pipe will be required. Most of this is 4-in. pipe; a small quantity being 10-in. and 8-in. Replacing of the wooden mains and the iron has not been fully decided by the engineer.

W. Va., Fairmount—City plans to purchase 1,700 ft. of cast iron pipe.

W. Va., Martinsburg—Clearing House Assn., of Martinsburg banks will advance $10,000, Interwoven Mills, $10,000, Berkley Woolen Mills, $5,000 and Dunn Woolen Mills, $5,000 to city for constr. of additional suction reservoir; also for repairing pipe line from spring to suction cistern and otherwise improving water system. Chas. W. Kilburn, Water Commr.

Wis., Eau Claire—Preliminary plans being prepared for 2½-3 miles 6-8 inch cast iron mains in various streets. Est. cost, $25,000. J. T. Hurd. City Engr.

Wis., Kohler—Plans under way for extension and improvement to water system. Will receive bids in Spring. Cons. Engr., Jerry Donohue Engrg. Co., Sheboygan. Steel tank on either old or new steel tower; abt. 1,000 ft. 6-in. cast iron water mains. Erwin Albrecht, Village Clk.

Wis., Marshfield—Bids will be taken in Spring on reservoir and standpipe. Jos. Schindler, Clk.: J. H. A. Brahtz, 409 Metropolitan Opera House Bldg., St. Paul. Reservoir, 3,000,000 gals. capy.

Wis., Portage—C. L. Loomis, City Clerk, will receive bids in near future for water purification plant, new pumping station, etc. Est. cost, $100,000. Pearse, Greeley & Hansen, 39 West Adams St., Chicago, Cons. Engrs.

Wis., Sturgeon Bay—$16,000 bonds voted here for water extensions. Edw. Ackerman, City Clk.

BUYERS' GUIDE

Pumps.
De Laval Steam Turbine Co.
Evinrude Motor Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Special Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Surface Heaters
Chausse Oil Burner Co.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

Tool Heaters, Asphalt
Chausse Oil Burner Co.

Turbines, Steam.
De Laval Steam Turbine Co.

Turntables, Truck
The Hug Co.

Valves.
Coldwell-Wilcox Co.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Republic Creosoting Co.

Wood Preservatives.
Barrett Co., The
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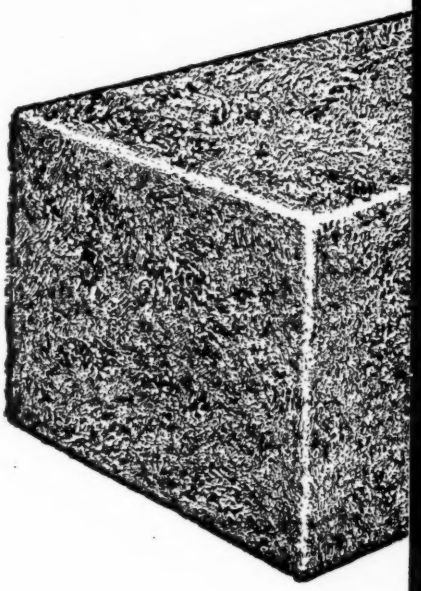

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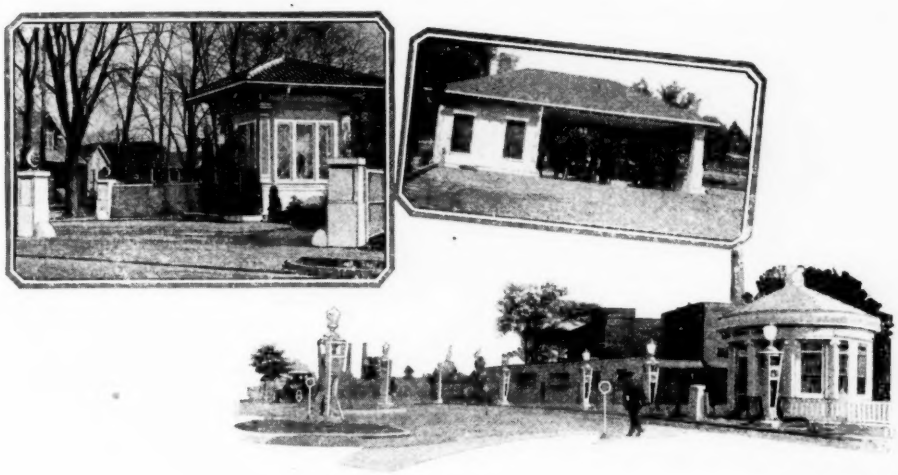

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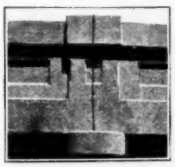

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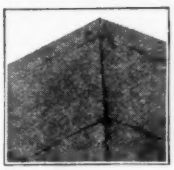

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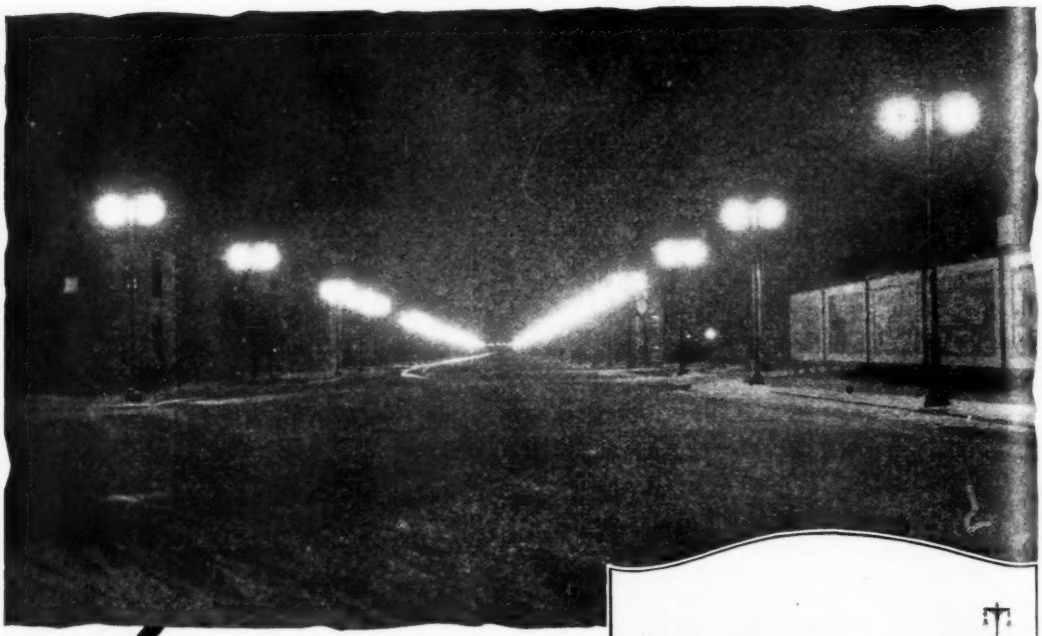

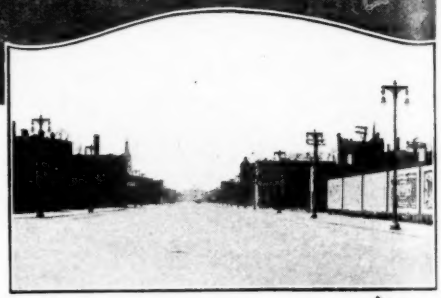

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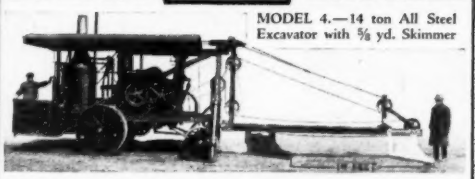

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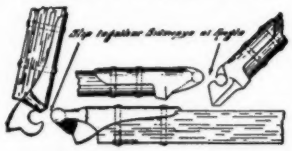

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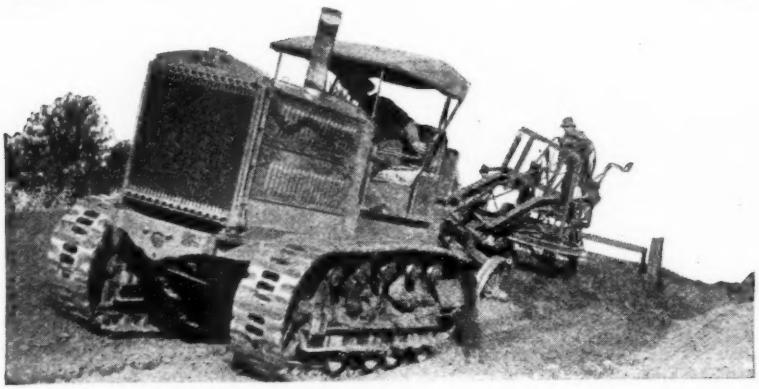

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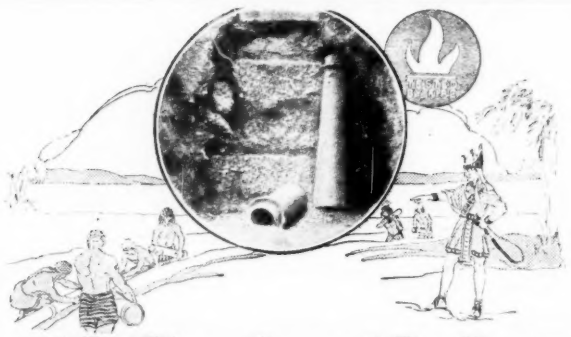

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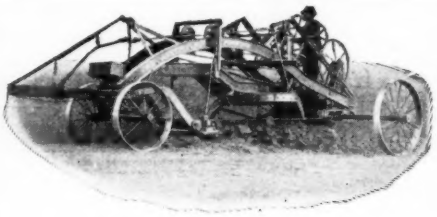

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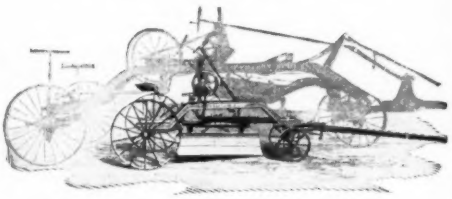

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COMPETITION AS A REGULATOR IN TRANSPORTATION

It is natural and proper that our ideas with respect to transportation should change from time to time with changing conditions. Rail lines were regulated because the rail managers, or some of them, abused their powers and their privileges. The public, once aroused, went to extremes in this class of regulation so that at the present time, as in recent years, the railways have ben regulated not wisely but too well. Many who formerly were strong advocates of the most rigid state and federal regulation of rail lines have greatly modified their views and now believe it would be better for the railway stockholders and the public if we should abandon commission regulation and return to statutory regulation. With this change there would be an end to governmental rate making and related matters and only such things as safety provisions, clearly definable by statute, would be controlled by the government. Such matters as rates and service would then be regulated by competition, not only as between rail lines, but, and this especially, between rail lines and motor transportation. Where a rail line has a real monopoly and conditions are such that competition is not likely to become operative it might be well to retain governmental regulation of rates and service, but where competition exists or where it will naturally come into being, if rail lines impose upon the public, it would seem advantageous to the public to allow the transportation agencies to fight it out just as competitors in other lines of business fight it out.

It must be evident to all, on reflection, that the coming of motor transportation has made a fundamental change in the relationship existing between the railways and the public just as the parcel post effected a change in the relationship that had long existed between the express companies and the public. If a rail line adopts a high-handed course in these days of motor transportation, the public will turn to motor transport for relief and this will quickly, fully and effectually correct any abuses the rail managers might practice. Again, between practically all important shipping points, duplicate rail facilities exist, and free competition between these rail lines will doubtless be in the public interest now that motor transport as a rail regulator is always within call to check rail collusion.

It often happens that those who adopt theories retain them more stubbornly than those who formulated them. This is true now in respect to this question of railroad regulation. The editor is proud to number among his friends two men who have been leaders of thought for many years in the complex field of utility valuation and regulation. These men have had the greatest responsibilities and the widest experience in this field. They agree that the time has come to remove the fetters from the railways and to let them compete with motor transportation. This seems to us the correct solution of the problem. The incorrect solution is the extension of commission regulation to motor transport, which is but the retention and extension of a measure of temporary value for which a need no longer exists.

CONTRACTING AS A BUSINESS

Two articles of unusual value as commentaries on contracting as a business are published in this issue. We refer to the articles entitled: "Highway Contracting and Its Illusions" and "Bonds as a Gauge of a Contractor's Responsibility." It is hoped that these articles will lead to a better understanding of the contractor's difficulties.

Almost every line of business, especially if it is highly competitive, seems to have one or more things, fundamentally, radically and irreparably wrong with it, if we are to take the word of a man engaged in that line. Thus the insurance man tells us that he may work for months or years on a prospect for a big policy and after the prospect is finally sold he is turned down by the medical examiner and the underwriter's efforts are fruitless. The real estate man complains that after making almost superhuman efforts to get a buyer and seller to agree and after agreement seems to have been established, either the buyer or the seller will back out when it comes to signing the papers, and the realtor is left with the exploded deal to bemoan his fate. Thus it goes in every line with the outsiders laughing and assuring the complainant that he doesn't know what a tough line is. But, in our opinion, the contractor's life is not one with which laughter can be associated except by those dauntless spirits who defy man and nature and engage in

it. After many years of observation it is our opinion that no other calling is so hazardous as contracting. The way society keeps on breaking the bodies, souls and fortunes of its members who engage in contracting is a challenge to our intelligence and our spirit of fair play. If we were asked to say what, in our opinion, is wrong with contracting, we should answer in two words: "Almost everything."

To begin with, the contractor must stand off the whole community and do it single-handed. Our loose conception of moral values prompts us to denounce and punish the contractor who cheats the public, but if we can outwit him, or take advantage of his misfortunes and make him pay very heavily as an individual for a public improvement we think we have made a good deal and have obtained something for nothing. Many public officials who would gladly send a contractor to prison for life if his foreman left out one bag of cement are supremely happy if the contractor bids too low and must make up the difference out of his own pocket. This is a disgraceful condition. Some way must be found to compensate the contractor for his skill and his work, not some of the time but all of the time.

MUCH HOSTILITY TO HIGHWAY TRANSPORT RESULTS FROM FORCIBLE APPLICATION OF MISFIT THEORIES

There is a surprising amount of hostility to highway transport, some of it natural, even if it isn't proper, and some of it unnatural. It is easy to understand the hostility of railway men to competing highway transport lines, but it is hard to understand why a good many men, who are not now, and who never have been, in railway service and who have never owned a dollar's worth of railroad stock, are so quick to take sides with the railways as against highway transport. There are two reasons for this condition of affairs: First, railway propaganda of all sorts has "gone over big" since the period of federal control, and, second, certain theories about valuation and rate making that were cut to fit the monopolistic conditions surrounding municipal public utilities have been ruthlessly wrenched out of their normal habitat and superimposed on rail and highway lines out in the country; not only has this done more or less violence to the theories, but the resulting fit is bad.

Take, for example, the element of competition and see how it differs as between two water utilities in the same town and parallel rail and highway lines out in the country. Most people agree that it is bad for a city to have two water utilities, as this means the duplication of investment without any compensating benefit. The only thing a water utility has to sell is water, and, under modern conditions, there is no reason to suppose that the water furnished by one utility in a city would be any better, or any different, from that furnished by the other. No good purpose could be served, then, by two separate investments to perform identically the same service.

Now contrast the case of the two water utilities in one city with parallel rail and motor transport lines between cities and it will be seen that there are fundamental differences between the two cases which do not justify competition in one case but which do justify it in the other. There is only one kind of pure and wholesome water in adequate quantity and at proper pressure and therefore only one kind of good water service, but in the case of rail and highway lines there are two kinds of transportation; to be strictly accurate, there are three kinds of transportation, namely, rail transportation, highway transportation *for hire* and highway transportation *not for hire*. Now if we were to duplicate investments in parallel rail lines that would be as bad as duplicating investments in overlapping water distribution systems, assuming that one line is properly managed and financed so it can function properly under the public's varying demands. But the highway gives two other forms of transportation, as stated, that are fundamentally different from rail transportation. We have never heard anybody say that it "isn't fair to the railroad" for a man to haul his own goods in his own truck, but many say it is unfair for him to compete with the rail line in transporting "for hire." This position is untenable as it destroys a fundamental right in the public road. In effect it means that a man must go into the motor transportation business in order that he may utilize motor transport. This reduces opposition to highway transport for hire to an absurdity.

CENTRAL PLANT HIGHWAY MAINTENANCE—POSSIBILITIES FOR LARGE CONCENTRATED MILEAGE

By Leroy C. Smith, Engineer-Manager, Board of Wayne County Road Commissioners, Detroit, Mich.

Much has been written about maintenance, about the necessity for it, about patrol or gang system, about organization, in fact every angle of this important function of road building has been fully discussed except the detail functioning of an organization which has the responsibility for a large mileage of paved roads to be maintained within a comparatively limited area.

Opportunity for the reduction of costs, the centralization of equipment, the checking up upon actual hours of employment, is greatly increased by having sufficient maintenance work to do within a given area the size of a typical county.

Wayne County's Problem

The Board of Road Commissioners of Wayne County have had a great problem before them in perfecting the actual means of executing the maintenance work promptly, economically, and efficiently. Over three hundred miles of concrete road are now under maintenance within an area of approximately 25 miles square. This is a territory upon which the travel for a 14-hour count runs as high as 15,000 vehicles a day on certain important arteries; and the average travel upon the whole system amounts to nearly 2,000 vehicles a day.

The intensive commercial traffic which is experienced in the territory adjacent to Detroit necessitates the continuous employment of a large, well organized force and much equipment, in this type of work.

Scope of Work

The work of this organization includes both that of regular road maintenance and road betterments. Under the former comes the following work: Cutting weeds and grass for the entire right of way width; building stone and bituminous shoulders; concrete patchings; tarring cracks and small depressions; trimming trees; snow removal; centerline marking; and maintaining lights and signs. Under the head of betterments; the building of new guard rails; sign boarding; tree planting; rebuilding and widening culverts; installing lights and signals; and widening roads with concrete.

Central Plants Serve

Two central yards have been established, located so as to keep the maximum haul to any road within the county down to about 15 miles. These yards cover an area of from two to three acres and have railroad facilities.

Both properties have been improved by the erection of garages 66x150 ft., equipped with boiler house, machine shop, forge shop, air compressor plant, and gasoline storage. In addition tar storage tanks have been erected adjacent to the railroad track, of a vertical, cylindrical type, mounted on concrete pedestals of sufficient height so that tar can be loaded into trailers by gravity.

These tanks have a capacity of 15,000 gals., thereby making it possible to take a carload of tar long before they are empty. The tar is unloaded from tank cars by compressed air. The tanks are insulated and have steam heating coils. Steam is supplied by central heating plant on the premises.

Cement storage is provided for by a good sized metal building having a capacity of about ten carloads. Stone, pebbles, and sand storage bins are located adjacent to the railroad track. These are provided with chutes for loading trucks; the material being handled from railroad cars to the bins by crawler-type crane.

Gasoline storage is provided in a buried tank having a capacity of 20,000 gals.

These permanently located yards with ample storage capacity for the various commodities which are used in road maintenance, provide a tremendous saving in the price of raw material, such as tar, the tank price being 50% lower per gallon than through the use of barrels. The differential between the tank car prices of gasoline as against filling station prices is over 5 cts. per gallon. These items alone are sufficient to justify the investment necessary for a central yard. Other savings of a like proportion are possible through the carload purchase of many other materials used in this work.

Gang System Employed

Three-quarters of the men employed start work from the central yards with trucks loaded for the day's use. These men have to punch a clock in going to work and punch out upon their return, the same as factory workers.

A foreman or straw-boss is in charge of each truck outfit, hereinafter described, together with the necessary squad of about seven men to carry on the day's work.

Bituminous Repair Equipment

Special trucks are used, ranging from 2 to 4-ton capacity with divided bodies providing space for sand, pebbles, granite chips, and cold-patch mixed material. The 2-ton trucks are being standardized upon pneumatic tires for speed and long mechanical life. In case of bituminous work, such as tarring shoulders or joints, the truck hauls a trailer, upon which is mounted a special tar tank having a capacity of from eight to ten barrels. This tank is equipped with kerosene burners and starts out with hot tank-load of tar sufficient for the day's work for the gang. This equipment is in sharp contrast with the two-barrel kettle on steel wheels heated with staves from tar barrels while the gang sits by the roadside waiting for hot tar. Instead, the tar is hot from the start and is kept hot by kerosene burners so that there is no loss of time in getting onto the job in the morning.

Concrete Repair Outfits

Gangs which are working upon concrete patching leave similarly from the central yard except that the heavy equipment, such as mixers and air compressor, are left on the job during the night. All broken or worn concrete is removed by "jackhamers" driven by compressed air furnished from a gasoline-driven air compressor mounted on a 5-ton trailer. This outfit is very easy to transport and can be moved from job to job as necessity warrants. Concrete mixers for patching are also mounted on trailers as it has been found they are more easily moved from job to job and the expense of loading and unloading is eliminated.

Material for Cold-Patch

Many small depressions can best be repaired by the use of cold-patch bituminous material. The aggregates and bituminous material for this purpose are assembled at the central yard, mixed in a permanently located concrete mixer and allowed to season in a stock pile from which the material is loaded on trucks for the various roads where the gang tamps it into any small depressions and holes in the road.

Railroad Crossings

The problem of properly maintaining the road surface at railroad grade crossings is still confronting us. Cold-patch material has best solved this troublesome matter.

By agreement and cooperation with the railroad company, old planks are torn out and penetration macadam built between the rails. This makes the smoothest and simplest crossing which we have to maintain. Without any interference to traffic, depressions in these crossings are filled with cold-patch and tamped in place, this material being distributed by trucks from central yards where it is mixed.

Roadside Beautification

The mowing of the roadside from fence to fence is done two or three times a year; all of the weeds and grass which can be reached from the shoulder of the road are mowed by power mowers directly attached to the transmissions of a Fordson tractor. A gang follows the tractor with scythes, cutting the remaining grass and weeds from the ditch back to the fence. It has never been possible to rig up mechanically to handle this work back of the ditch line.

The care of roadside trees and the setting out of new trees is also handled by the gang system, motor trucks being equipped with power spray apparatus and with water tanks for watering young trees. The young trees are bought in carload lots, the roots are temporarily buried until holes are dug and provisions have been made for setting out the entire shipment. A nursery is planned whereby young trees, shrubs and all sorts of landscape growth will be available continuously for the beautification of our roads.

Special equipped 1-ton trucks are provided the trimming gangs for pruning and preserving the existing trees. These trucks are equipped with extension ladders, tackle, saws and tool boxes to do all sorts of forestry work. An experienced forestry foreman under the direction of the maintenance superintendent supervises this work.

Snow Removal

Provision is always made for the removal of snow from the highways within a few hours after it falls. We do not have to contend with heavy drifts or snow falls of over 6 ins. except occasionally. We are, nevertheless, fully equipped to handle this work with blade snowplows attached to the front end of over half the trucks in our fleet. These trucks are stored in warm garages and are ready in the winter at any time to go out promptly and work continuously on snow removal. For heavy drifts "caterpillar" tractors, equipped with rotary mechanical plows are recommended but in the climate in which the writer is located it is more economical to handle heavy drifts by hand.

White Centerline

The entire mileage of Wayne County's roads has the centerline marked with a 4-inch white paint line. This is done by a single Ford truck upon which is mounted a power paint spraying machine. As the truck is driven down the road a stream of paint is fed upon a trailing felt wheel which transfers the paint to the pavement. It is possible to cover as high as 20 miles per day with this equipment. By keeping it regularly employed the white line is maintained in excellent condition for our entire 300 miles of road.

Gas and Electric Flashing Lights

At every important road intersection a flashing green light has been installed to warn approaching traffic of the intersecting road. These lights are maintained by mechanics from central yards, to whom are reported by telephone any damage done by collision or otherwise to this equipment. Complete spare lights are kept in stock so that an exchange can be made, taking the damaged beacon light to a fully-equipped shop for repairs. At electric railway crossings flashing red electric lights are installed overhead 15 feet above the road, warning of the approach to the crossing. These lights are also maintained by electricians working out of the central yards.

Sign Painting

A complete paint shop in charge of a competent sign painter at each central yard maintains our elaborate system of road signs throughout the country. The painting of these signs is all done in the shop and when a sign needs repainting an exchange is made rather than going out on the ground to do the painting.

Conclusion

The efficiency of the centralized maintenance organization is reflected in the fact that expenditures for this purpose during 1923 have exceeded the previous year by only 2½% while the mileage of road which must be cared for has been increased by 18% over that of previous years.

The foregoing paper was presented by Mr. Smith at the recent Annual Convention of the American Road Builders' Association.

SUCCESSFUL DYNAMITING AT 35 DEGREES BELOW ZERO

Tests were recently conducted at Hibbing and Virginia in Northern Minnesota which prove that ordinary straight 40% dynamite now being made by the du Pont Company on a low freezing formula was practically unaffected at a temperature of 35 degrees below zero. A continuous series of tests which had been made during the comparatively mild winter weather at those points when the temperature was at zero or a few degrees below, proved that the low freezing dynamite would detonate without difficulty. In the test made at 35 degrees below zero, it was shown that one cartridge would detonate another at 1 foot.

The development of this low freezing dynamite is considered to be the greatest advance made in the explosives field since the invention of dynamite by Nobel. It makes possible the use of dynamite in road building and all kinds of open construction work under any temperature encountered in the United States. The development of the low freezing dynamite was not accomplished over night, but has been gradual work.

Arthur La Motte, Manager of the Technical section of the du Pont Company, recently reviewed the efforts made to develop dynamite which would withstand low temperatures. "About 1908 the Du Pont Company made some low freezing gelatin dynamite which withstood temperatures down to zero on a contracting job in the Berkshire hills," he said. "The contractors on that job found that the explosive had the remarkable property of retaining the summer strength without being thawed and they continued their work uninterrupted by any temperature encountered. This low freezing gelatin was continually improved until last year when a method was found for handling the low freezing nitro-glycerin which enabled it to be used in nearly all du Pont high explosives, the improvements resulting in their successfully withstanding temperatures as low as 35 degrees below zero. Of scientific interest it might be stated that the inoculation of this dynamite at 15 degrees below zero with a crystal of frozen nitroglycerin made on the old formula resulted in no freezing of the modern dynamite."

This low freezing dynamite created a sensation last year when it was used in some ditch blasting work in the Northern states. The night before the ditch was shot, the explosives had been subjected to a temperature of 10 deg. below zero. The ground was frozen and covered with snow. The next day the holes were

punched through the frozen ground, and the dynamite put down. It was shot by the propagation method where the detonation of one cartridge sets off the others. There was no difficulty whatever experienced. The dynamite showed the same qualities which it would show in the summer time.

A CRITICISM OF THE BOOK "CITY PAVEMENTS" WITH SPECIAL REFERENCE TO BITUMINOUS MIXTURE DESIGN

By Gene Abson, Chicago Paving Laboratory, Consulting Engineers, 536 Lake Shore Drive, Chicago.

In his recently published book, "City Pavements," Major F. S. Besson, U. S. Army Corps of Engineers, devotes Part IV to Bituminous Pavement construction, in which Chapter XVI designated as "Design of Bituminous Mixtures," attempts to expound the theory and practice of bituminous pavement construction in the United States. The material in this chapter has appeared previously in an article entitled "Bituminous Paving Mixtures, Aggregate Survey" in "Municipal and County Engineering" of October, 1921; notable omissions from this article are made in the book, the chapter referred to above being merely an excerpt.

Revolutionary Proposals

Perusal of the first article at the time of its appearance evoked considerable comment, but so far as is known, no written discussion has ever appeared. Now that the material has appeared in book form and is advertised as an authentic and reliable source of information, it seems a propitious time for a fair discussion of the soundness, practical value and correctness of the theory advanced. In general, Major Besson's views, if they can be accurately extracted from his writings, are extremely radical and advocate complete revision of asphalt pavement construction, based purely upon an arbitrary formula of his own development and take little or no account of the knowledge gained in 40 or 50 years of experience by men who have devoted their lives to this field of endeavor. Specifically, the present discussion will be taken up in as near the order of the book as possible.

Royalty Payments

In the second paragraph, he states that "practically all mixtures that have hitherto been used throughout the United States have been prepared according to one or another of several well-known or patented formulae." Surely this is not true! It is possible to lay any type of paving mixture showing any desired combination of particles of aggregate without danger of patent infringement, or without necessarily resorting to a formula other than that which practice has proven to be correct. At any rate, such is being done every day. In the last 20 years, and perhaps even 40, sheet asphalt pavements have been laid to the extent of millions of square yards in all sections of the country with the use of local sands, judiciously selected, and without one cent of royalty payment.

Sands

The contention that local sands are not used in bituminous pavements is absolutely without foundation. Conversely, the statement that any aggregate which can be used for Portland cement concrete aggregate can be successfully employed in bituminous mixtures is in direct contradiction to years of experimental work and the opinions of numerous engineers who are experts in this practice; a possible exception to this might perhaps be found in isolated cases with some concrete sands which could be employed in extremely coarse aggregate types of bituminous mixtures requiring no mineral filler. Examples of pavement failures due to inferior sand grading are known to all who are familiar with asphalt pavement work.

The Binder Course

The next paragraph attacks the so-called "mystery of the use of a binder course," and advocates the entire elimination of it on the basis that it is non-essential. There are in reality several good reasons why binder should be laid in addition to the fact that its use has proven of extreme value in preventing displacement of the wearing surface on heavily traveled pavements. Numerous examples of one-course pavements which have failed can be shown in opposition to one 42 year old pavement which has been used as a criterion.

On the other hand, no pavement ills can be attributed to a properly designed binder course. The comparison of a 42 year old street with a recently constructed pavement leads to some erroneous deductions. During the greater part of the existence of the old pavement it has been subjected to only the traffic then in vogue, namely, light, horse-drawn vehicles, and has been gradually compressed and has dried out; the fact that it is

today a good pavement is dependent upon this. A street laid today with the same mixture would undoubtedly be destroyed in a comparatively short time.

To be successful under modern traffic conditions with the enormous volume and increase in loading, the mixture must approach the present condition of the old, successful pavements. To help stabilize and keep in place, the binder course has proven its utility and if any changes are made, the thickness should be increased. In fact, this latter procedure is being religiously followed in numerous large cities.

Among the functions of a binder course may be enumerated the stabilizing effect by means of a greater friction bond, especially with sheet asphalt on a concrete base; taking up irregularities in the surface of the base; providing greater depth of traffic cushion at a lower cost than the same thickness of top mixture.

Pavement Defects

In Section 295, entitled, "Normal Bitumen Requirements," Major Besson is correct in asserting that the two failures which may be encountered in bituminous pavements are "cracking and waving"; this, however, is not the full extent of pavement ills and in the list should be included rutting (manifestation of the same defect as causes waving but produced by different kind of traffic), raveling and spalling. He also states that cracking is due to two causes, "lacking of rigidity in bases and improper mixture." Has he ever opened up a crack in an asphalt pavement and noticed the exact surface reproduction of the crack in the concrete base, conclusively proving the fault to be in the rigidity of the base?

Cause of Waving

In the next paragraph he states that no remedy for, or knowledge of the cause of waving has been determined. When it has been demonstrated many, many times that pavements can be laid on the heaviest traveled boulevards and truck-traveled streets which will not wave or rut, it appears that the problem is not wholly devoid of correction nor is it one of conjecture. The "mysterious secret" is, of course, the relation of sand grading, filler and bitumen content, together with the penetration of the asphalt cement, method of rolling, street operations and temperatures.

Normal Mix Diagram

Then, in view of the above and with absolutely no scientific, practical or otherwise sound foundation, the Major confronts his readers with a "normal mix diagram" which he states was evolved from an examination of a number of pavement samples. How were these tested and why should not the mixture analysis, history of the pavement, penetration of the asphalt cement, method of compressing, etc., be given so that proper inferences may be drawn?

The fallacy of basing judgment of mixtures upon such a diagram (recently patented by Major Besson) can be readily shown. A glaring fault with the diagram and one which is extremely important in ascertaining a proper reading, is his method of making voidage tests. Pouring the loose aggregate into a cylinder without shaking, tamping or compressing to insure maximum compactness and density with the elimination of air, is difficult to perform with reasonable accuracy and gives false percentages of voids for a comparison with a rolled asphalt mixture in which the voids are necessarily at the minimum for the grading. The loose aggregate should be compacted in order to arrive at any reasonable results; accepted methods for voidage determinations are based on some method of compacting, either ramming, tamping or jarring.

Determination of Voids

The use of water in determining voids in sand and stone aggregates is not accurate for the reason that the absorbed aqueous vapor leads to a false reading. Actual determinations may upon identical samples show as much as 40 per cent difference in voids between Major Besson's method and a method of compacting; this, according to his chart, would mean a difference of 6 per cent by weight of bitumen between maximum and minimum. For a pavement aggregate in which ½ of 1 per cent variation in bitumen is considered ample, it is easily seen that such wide variation is far beyond scientific accuracy and demonstrates the inaccuracy of his methods.

Referring again to his chart, it is shown that the lowest limit for voids considered is 28 per cent. It is easily possible to combine a mixture of sand, filler and stone (and not infringe upon any patents) to obtain a voidage of 14 per cent or lower. This would be eliminated from use entirely by the chart on account of being "too compact" even though pavements such as this have been laid for 15 years and are still in excellent condition.

A number of combinations of aggregate now used in Chicago and elsewhere were

made up, one or two of which offer good demonstrations of the uselessness of this chart.

(1) A combination of Chicago Lake sand and silica dust, as follows:

Passing 200-mesh	19.5%
Passing 80-mesh	34.7%
Passing 40-mesh	31.7%
Passing 10-mesh	14.1%

This mixture gave 37.2 per cent voids by the Besson method and only 27.3 per cent by the method of compacting. The combined aggregate showed a specific gravity of 2.66, which, by the chart, shows the proper percentage of bitumen to 6.5. To one familiar with sheet asphalt mixtures, it would be unnecessary to say that such a mixture would never be laid—the bitumen would be just about enough to coat the particles of sand and filler a light brown and would not compact under the rollers. Calculations made with the above data show that the bitumen necessary to fill 27.5 per cent voids is 10.6 per cent by weight; with 37.2 per cent voids, bitumen required is 14.5 per cent by weight.

(2) Another sand mixture without the use of dust, showing a specific gravity of 2.63 and grading as follows:

Passing 80-mesh	40.0%
Passing 40-mesh	40.0%
Passing 10-mesh	20.0%

gave a voidage of 33.5 per cent, requiring by the diagram exactly the same percentage of bitumen, namely, 6.5. The bitumen necessary just to fill the voids would be 13.2 per cent by weight. Such a combination would be a "mastic" rather than a pavement mixture.

Block Test

No detailed criticism of the "Block Test" will be given in this paper for the reason that a thorough discussion would be too prolix. The fact that it is entirely dependent upon the "normal mix" diagram, which has been shown above to be misleading and inaccurate, naturally places it in the same category. As a typical example, one section, namely 301, may be cited. In the third paragraph is offered a comparison between different aggregates, neither of which, by the way, would be considered as a satisfactory sheet asphalt sand. By the aid of the diagram and the Block Test, the conclusion is drawn that the coarser sand is the better. When it is noted that the No. 10, or finer sand, shows a grading which would be considered coarse in all standard specifications, and that only 10 per cent of filler, together with 11 per cent bitumen composed the mixture as tested, it is at once apparent why this mixture was the more susceptible. The bitumen is about 10 per cent too high, and the dust content from 30 to 50 per cent lower than modern practice necessitates.

Such deductions are not only evidence of lack of knowledge concerning bituminous mixtures, but are also of serious consequence. Voidage undoubtedly plays an important role in the theory of asphalt paving mixtures when properly interpreted. To say that voidage in the abstract is the determining factor, has been shown above to be fallacious. The real secret is the relation of the size of the voids to the total voidage. To one familiar with the physical characteristics of aggregates whether they be sheet asphalt, stone-filled sheet mixtures or asphaltic concrete, it has been apparent that as the size of the individual voids is decreased, the mixture as a whole compacts with astoundingly greater ease and becomes more dense, even though the resulting density (or voidage) remains the same. With voids reduced to a judicious combination of minimum individual size and minimum total, it is comparatively easy to ascertain the proper percentage of bitumen required to fill the voids and cement together the particles; the appearance of the mixture when hot, the handling of it on the street, the action under the rollers, etc., are aids to the experienced engineer in determining this factor.

The fact that diffierent aggregates under similar conditions do not act the same, and that varying traffic conditions necessitate dissimilar mixtures, tend to make it almost impossible to devise a laboratory test which will prove conclusively that a certain combination is going to be successful. The only reliable basis of judgment is the experience and practicability of expert engineers, rather than a complicated theory, diagram or testing machine which is superficially correct but not entirely reliable or adaptable.

DISCUSSION ON: AN IMPORTANT HYDRAULIC FACTOR IN CULVERT DESIGN

To the Editor:

My attention has been called to an article which appeared in the September (1923) issue of your periodical, entitled, "An Important Hydraulic Factor in Cul-

vert Design," by C. E. DeLeuw, and which is now being circulated as a reprint by the American Concrete Pipe Association, 111 West Washington Street, Chicago.

The author of this article has referred to recent experiments performed at the hydraulic laboratory of the State University of Iowa, and seems to infer that these experiments form the basis for the table of culvert capacities which he has presented with the article.

As a matter of fact, the table which he presents for the capacity of corrugated and concrete pipe culverts is grossly inaccurate, and exaggerates the difference between the capacities of the two types of culvert pipes. It is absolutely impossible for an ordinary culvert to have the capacities shown in this tabulation.

A possible explanation of his error lies in his totally erroneous statement: "The entrance and velocity losses are disregarded as they are practically the same for each material with a given type of entrance."

As a matter of fact, the velocity head and entrance losses are of such magnitude in pipes as short as culverts, that they can not be ignored.

As an example of the wide divergence between Mr. DeLeuw's figures and *actual capacities measured* in our experiments, I have selected *at random*, the 30-in. diameter pipe, 1% gradient, 30 feet long:

	Corrugated Metal c.f.s.	Concrete c.f.s.	Pct. Dif.
C. E. DeLeuw Table....	23.60	41.73	77%
Iowa Univ. Exper.....	14.1	16.40	16%

From this it is seen that Mr. DeLeuw's figures not only exaggerate the capacities of both types of culverts, but even to a much greater extent exaggerate the difference between the corrugafed metal and concrete culverts, in favor of the latter, the actual difference between the two types being only 16%, *not* 77% as stated by Mr. DeLeuw. In conclusion, may I state that it would seem that this "hydraulic factor in culvert design" is not as "important" as the author of the above article would lead us to believe?

Very truly yours,

FLOYD A. NAGLER,

Department of Mechanics and Hydraulics, The State University of Iowa, Iowa City, Iowa.

(In line with the usual editorial procedure, the foregoing letter by Professor Nagler was submitted to Mr. DeLeuw for his consideration to give him opportunity to reply to it if he so wished. Mr. DeLeuw has prepared the following reply. —Editor.)

To the Editor:

I have read with interest Prof. Floyd A. Nagler's letter relative to my article on "An Important Hydraulic Factor in Culvert Design," published in the September (1923) issue of Municipal and County Engineering. The table which was published in that article was set up with a view to showing the carrying capacity of the two kinds of pipe as determined by the frictional losses. It was plainly stated that "entrance and velocity losses were disregarded in making these calculations." I did state, however, that these losses were substantially the same for a given type of entrance, regardless of the material used in constructing the body of the culvert.

There can be no doubt of the importance of the velocity and entrance losses in short culverts and it is a well-known fact that they vary greatly with the type of entrance used. I did not advocate ignoring these losses, and it is greatly to be regretted if the phraseology used gives this impression to the casual reader. The Bureau of Public Roads has published within the past few months its conclusions from the Iowa experiments which were made on culverts of corrugated metal and vitrified clay pipes 30 ft. in length. I take the liberty of quoting at length from their Bulletin as follows:

"*Conclusions.* The following general conclusions have been drawn:

"1. The discharging capacity of a pipe culvert depends primarily upon the cross section of the pipe and the difference in water level at the two ends of the culvert.

"2. To obtain the maximum discharge the pipe must be so laid as to insure the full cross section of the pipe being filled by the flowing water.

"3. If the pipe is laid at too high an elevation with respect to the water levels at the two ends of the culvert, it will not run full and hence will not attain its maximum capacity.

"4. If a culvert pipe is so laid that both its upstream and downstream ends are completely submerged the amount of water which it discharges will be proportional to the square root of the difference in water level at the two ends, and the exact grade at which the culvert

pipe is laid has no effect whatever upon its maximum discharging capacity.

"5. The co-efficient of roughness, *n*, in the Kutter formula, for the vitrified clay pipe ranges from 0.010 for the 12-in. size to 0.013 for the 30-in. size.

"6. The co-efficient of roughness, *n*, in the Kutter formula, for the corrugated metal pipe ranges from 0.019 for the 12-in. size to 0.023 for the 30-in. size.

"7. In vitrified clay and corrugated metal pipe culverts, 30.6 ft. long, with straight-end-wall entrances:

(a) The 12-in. vitrified clay pipe will carry about 65 per cent more water than the 12-in. corrugated metal pipe.

(b) The 18-in. vitrified clay pipe will carry about 50 per cent more water than the 18-in. corrugated metal pipe.

(c) The 24-in. vitrified clay pipe will carry about 40 per cent more water than the 24-in. corrugated metal pipe.

(d) The 30-in. vitrified clay pipe will carry about 30 per cent more water than the 30-in. corrugated metal pipe.

"8. The effect of the length of the culvert on the discharge is not as great with vitrified clay pipe as with corrugated metal pipe.

"9. The 45-degree wing walls used in connection with a corrugated metal pipe culvert will increase the capacity from 1 to 10 per cent over that of a metal pipe culvert with a straight end wall.

"10. The 45-degree wing walls used in connection with a corrugated metal pipe culvert are more efficient when set flush with the edge of the pipe than when set 6 ins. back from the edge of the pipe.

"11. The 45-degree wing walls used in connection with a corrugated metal pipe culvert are more efficient when built to the top of the headwall than when built only to the top of the pipe.

"12. The 45-degree wing walls used in connection with a vitrified clay pipe culvert are not as effective as the straight-end-wall entrance with the regular bell end upstream.

"13. The U-type wings used in connection with a vitrified clay pipe culvert are not as effective as the straight end wall.

"14. The bell end at the entrance of vitrified clay pipe culvert, by virtue of its shape, assists greatly in reducing the entrance loss.

"15. A 24-in. vitrified clay pipe culvert, 38 ft. long, with a straight end wall and the regular bell end upstream will carry about 10 per cent more water than will the same culvert with a square-cornered entrance.

"16. By merely rounding the entrance to a pipe culvert the capacity may be increased approximately 13 per cent over that obtained in a sharp-cornered entrance."

TABLE II—CAPACITIES OF CULVERTS OF VITRIFIED CLAY AND CORRUGATED METAL PIPE. STRAIGHT END-WALL ENTRANCE. LENGTH 30.6 FT. DISCHARGE IN CUBIC FEET PER SECOND.

Head on Pipe in Feet	12-in.		18-in.		24-in.		30-in.	
	Vit. Clay	Cor. Metal	Vit. Clay	Cor. Metal	Vit. Clay	Cor. Metal	Vit. Clay	Cor. Metal
0.01	.51	.31	1.17	.78	2.10	1.51	3.31	2.53
0.05	1.14	.69	2.61	1.74	4.69	3.38	7.39	5.65
0.1	1.61	.97	3.69	2.47	6.63	4.78	10.5	7.99
0.4	3.23	1.94	7.38	4.93	13.3	9.56	20.9	16.0
0.7	4.27	2.57	9.76	6.53	17.5	12.7	27.7	21.1
1.0	5.10	3.07	11.7	7.80	21.0	15.1	33.1	25.3
2.0	7.21	4.34	16.5	11.0	29.7	21.4	46.8	35.7

(Table II is included in the matter quoted.—Editor.)

It is to be noted that Table II is calculated for straight end wall entrances, in which type the entrance losses are relatively large. With more efficient entrances and greater lengths of culverts, the comparative capacities will be governed more clearly by the coefficient of roughness of the material used in construction of the culvert. It follows that the above noted increases of capacity through vitrified clay pipe over that through metal pipe will be greater with more efficient entrances and greater lengths of culverts.

No experiments were made at Iowa, to the writer's knowledge, on concrete pipe. However, most engineers are familiar with the frictional losses in concrete pipe as compared to those in vitrified clay pipe, and the reader is privileged to make his own deductions.

I see no reason to alter my original conclusions that the coefficient of roughness of the pipe is an important factor in culvert design. Perhaps the design of the culvert entrance is of equal importance, and the publication in full of the results of tests on various types of culvert entrances is anticipated with pleasure. The engineering profession is greatly indebted to Professor Nagler and his associates for their important contributions on these subjects.

Very truly yours,

C. E. DeLEUW,

Of Kelker, DeLeuw & Co., Engineers,
Conway Bldg., Chicago, Jan. 30, 1924.

(Mr. DeLeuw's letter was brought to

the attention of Professor Nagler, who has written the following reply.—Editor.)

To the Editor:

I am certainly indebted to Mr. DeLeuw, in his reply to my criticism of his article on "An Important Factor in Culvert Design," for his extended quotation from a bulletin of the Bureau of Public Roads which summarized some of the conclusions from the Iowa Culvert Experiments.

Table II, quoted from this bulletin, presents quite a contrast to the figures proposed by Mr. DeLeuw in the original article and demonstrates quite conclusively the erroneous results which are obtained "When only the friction factor is considered." The gradient of 1 per cent, assumed by Mr. DeLeuw in the computation of his Table I, is practically equivalent to a fall or "head" of 0.3 ft. in a culvert 30.6 ft. long. Values of capacity which correspond to this gradient can be obtained by interpolation from the Table II which Mr. DeLeuw gives in his letter or from portions of the table as given in the bulletin which were not copied by Mr. DeLeuw. The following tabulation presents these values for vitrified clay and corrugated metal in a manner so that they may be easily compared with the "culvert discharges" presented by Mr. DeLeuw in his paper.

	—12-in.—			—18-in.—			—24-in.—			—30-in.—		
	Conc.	Vit. Clay	Cor. Metal	Conc.	Vit. Clay	Cor. Metal	Conc.	Vit. Clay	Cor. Metal	Conc.	Vit. Clay	Cor. Metal
Iowa Experiments		2.79	1.68		6.39	4.27		11.5	8.28		18.1	13.8
DeLeuw Table I	3.40		1.83	10.17		5.70	22.78		12.70	41.73		23.6

As I asserted in my former letter, Mr. DeLeuw's analysis not only exaggerates the discharge of the different culverts by more than 150 per cent in some cases, but also magnifies the relative difference in the carrying capacity of the two types of culverts.

I agree with Mr. DeLeuw in his statement that the friction factor is important in determining the carrying capacity of culverts made of different materials, but it certainly is not of as great significance as Table I in his article would lead one to believe. In this connection it should be noticed that the discharge of concrete culverts can not be deduced directly from the capacities for vitrified clay culverts as presented in Table II, for because of this "friction factor" a concrete culvert has been found to have as much as 10 per cent less capacity than those given for the vitrified clay culvert in this table. The Iowa experiments included an investigation of the carrying capacity of concrete culverts which was fully as extensive as that conducted upon the vitrified clay and corrugated metal pipe. Due to the fact that the experiments upon the concrete pipe were not completed until June, 1923, no summary involving this type of culvert could be included in the bulletin from which Mr. DeLeuw quoted.

Mr. DeLeuw's conclusion that "the increases in capacity through vitrified clay over that through corrugated metal pipe will be greater with more efficient entrances" has not been verified by the Iowa experiments, and, in fact, the Conclusions Nos. 9, 14, 15 and 16, which he quoted, prove that quite the reverse is true. The figures given for vitrified clay pipe in Table II are those for a culvert set in a head wall with bell-end upstream Conclusion 14 states that this type of entrance is quite efficient. No. 15 states that by reason of such an entrance 10 per cent increase in discharge may be realized over that obtained with a square corner. But since No. 16 states that only 13 per cent increase is the maximum obtainable with the most efficient type of entrance, it can be deduced that only 3 per cent additional capacity for vitrified clay pipe can be obtained by entrance modifications, over that given in Table II (for the 24-in. pipe). Yet from Conclusion No. 9 it is seen to be possible to increase the discharge of a corrugated metal pipe by more than 10 per cent with an entrance which is no more efficient than a 45-degree wing wall, and certainly, even more than this could be realized with a well rounded entrance. Hence it is a fact that "increases of capacity through vitrified clay pipe over that through corrugated metal pipe" may be *LESS* "with more efficient entrances" than those given by Table II.

I hope I have demonstrated that entrance and velocity losses CAN NOT be "disregarded" in making culvert computations. But, I must also take exception to another statement made by Mr. DeLeuw in his article and repeated in his letter: "that these losses were substantially the same for a given type of entrance regardless of the material used in constructing the culvert." These entrance and velocity losses expressed as a

function of, or ratio to, the square of the mean velocity in the culvert would probably be the same regardless of the culvert material; but this is far different from asserting that the *magnitude* of the losses would be the same for culverts with similar entrances discharging under the same head or gradient. Due to the fact that culverts of different materials have different "friction factors" (as Mr. DeLeuw seems so anxious to demonstrate), even though the entrance conditions may appear the same, the mean velocity in each will be different under the same head or gradient. Hence, since the velocity will be somewhat greater in the more nearly frictionless culvert, this culvert will be found to have a GREATER entrance and velocity loss than the culvert with a higher friction factor. It will be found, therefore, that, with like entrance conditions and under the same head (or gradient) the entrance and velocity losses for the corrugated culvert is not equal to *but LESS than*, similar losses measured in a clay or concrete pipe culvert. This is an additional reason why these losses can not be disregarded, and any comparison of capacities of culvert pipe based only on friction factors leads to a grossly erroneous exaggeration.

Very truly yours,
FLOYD A. NAGLER,

Department of Mechanics and Hydraulics, The State University of Iowa, Iowa City, Iowa, Feb. 9, 1924.

BONDS AS A GAUGE OF A CONTRACTOR'S RESPONSIBILITY

By N. F. Helmers, of Siems, Helmers & Schaffner, Inc., St. Paul, Minn.

Within the last few years, an association has been formed, called the Associated General Contractors of America, which is rapidly grouping together the real constructors of this country. Their motto is skill, integrity and responsibility.

This association has had sufficient dealings with the engineers, the architects, the American Association of State Highway Officials and other associations engaged in the construction industry to indicate that the Associated General Contractors is recognized as a representative body for the contractors. It is our desire to see that the members fully comply with the spirit of the motto, skill, integrity and responsibility, and why? Because it should go without saying that the real assets of any constructor are, and necessarily must be, skill, integrity and responsibility.

Skill Includes Knowledge of Costs

We fail to find any experienced engineers, or fair owners, who want any other type to handle their construction work. The three words should require no explanation or definition, but I want to submit that in the construction business, necessarily skill must include not only the knowledge of how to do work, but of *having full knowledge of what constitutes costs of that work.*

Particularly since the advent of the large road-building programs in this country, we have had a large increase in public lettings. This means that instead of having the private owner who can select a few contractors whom he deems desirable, practically any one can submit a figure on public work. In connection with this, permit me to call your attention to one peculiar fact, and that is that the novice or man who has not previously built a certain type of construction always thinks that it can be built for less money than is really the fact. He rarely errs in being too conservative.

Low Bids and Contract Awards

Following up the above reasoning, we find that the private owner has always had a means of selecting the type of contractor he desires. In the past, the largest work in the heyday of railroad construction was handled by employers who could select. The highway engineer, the city engineer, or any other public servant, has not that privilege. In most cases, he is tied down by law to let his work to the lowest responsible bidder and this means anyone able to secure a bond. Happily, in some places, because of the bad results from this type of letting, special legislation has been passed enabling the engineer to require a questionnaire as to finances, experience, equipment and past performance, and to use this information in making decisions of award. However, in many instances, even when the engineer has this choice, he will be subjected to political log-rolling because he has hanging over him the prevailing idea that the responsible bidder is the one who puts in the lowest price and can provide a bond.

Postponements Costly

But is this true? When the state, the county or municipality, as may be, wants to let a piece of work, it is usually a case

where the need of that work has been established as a paramount issue. It must be properly built and it *must be produced at the earliest possible moment*, as in most every case it has already been established that unless the need is supplied, the state, county or municipality, and every citizen, is suffering indirect loss through lack of it. For instance, a hard surface road is projected in a certain locality. Why? Because it is badly needed and the traffic is too great for any other class of road. Every day that this work is not produced, every interested taxpayer has certainly experienced a loss in operating his car over detours, etc. You can apply the same reasoning to every type of contract, bar none.

Who is Lowest Responsible Bidder?

If this is so, then who is the lowest responsible bidder? He must be the man who has the necessary reserve back of him to finance the work properly, who has available the necessary equipment to complete the work properly, who has the necessary organization to handle that equipment and to do the work, and who has the *known* ability properly to supervise and push that work to its ultimate conclusion *within the desired time limit.* Now then—when a bonding company essays to underwrite the lowest responsible bidder on a piece of work, they are taking on a serious responsibility to the state, county, municipality, the taxpayer and public at large. In the last analysis they are the ones to say who is a responsible bidder or who is not. They certainly should be, and really are, accountable for their stewardship to the nation.

As the matter stands today, the attitude of the bonding companies in connection with that little phrase, the "lowest responsible bidder," is the rock on which the construction business of the United States is being dashed to pieces.

Careless Bonding Increases Premiums

Some 14 years ago, when I entered the contracting field, and I assure you it was on a very small scale, I found that the bonding company which was willing to handle my case, felt it necessary to inquire carefully into what work I had done before, and in a general way as to my ability as a construction man and as to whether or not I had knowledge of costs sufficient to justify my bond. These were apparently as much, or really of more value, than the funds I had available. If that were the situation today, I do not believe we would be trying to make a case against the bonding companies. But what do we find? We find that because of poor risks taken by the bonding companies, the premium has been increased over 1,000 per cent so that it is now 1½ per cent of the total cost of the work. We learn that the field agent is being paid an unreasonable percentage amounting to as high as 25 to 35 per cent of the total premium in order to secure business. His method blinds him to any idea of safeguarding his employer, the bonding company, and in many cases we are certain that the bonding company accepts the risk on what looks to be a fair statement of facts, but which are not such, in reality.

Results of Easy Bonding

This way of getting business can have only one outcome; namely, that a bonding company trapped through lack of foresight on the part of its staff or its agent, is prone to take unfair advantage of technicalities, and in very many cases it has therefore been necessary for the owners to bring suit against the bonding company to force it to comply with what it has already agreed to do, namely, underwrite the work. And bear in mind that any fair underwriting of that work does not merely mean to complete it, but *to complete it on time.* I ask you how many cases have you heard of when work has stopped through default and it has been necessary to make arrangements with a bonding company, where the work has been finished on time? Indiscriminate low bidding by inexperienced people, underwritten by careless bonding companies has caused a very serious situation in the construction field. Old construction companies of established reputation are dropping out of the field of public construction. Engineers in charge of such work are being forced to the conclusion that such bonding has no real value. They, and the contractors in general, are seeking an outlet which will give the experienced contractor an opportunity to get the work. They can clearly see the loss which constantly occurs from the policy of getting a low bidder that doesn't come through.

At a joint meeting of the Committee on Co-operation with Contractors and a committee of the Associated General Contractors of America, held in New Orleans December 4, certain matters pertaining to highway costs and contracting prac-

tices were deliberated and conclusions pertaining thereto were reached as herewith outlined:

Surety Bonds and Bonding Practices

"The expansion of hard surfaced highways has been attended by such an influx of new construction companies into this field that many contractors have secured contracts which they are incapable of performing. Much unnecessary engineering expense, friction, improper conduct of construction, expense to taxpayers in being deprived of the use of roads and other unfavorable contingencies are resulting from the bonding of irresponsible contracts.

"By reason of their ability to obtain a corporate bond (and the practical credit which goes with a guarantee of labor and material costs) many concerns inadequately experienced have been able to secure and embark upon the execution of large projects and have subsequently defaulted.

"Engineers would not willingly award a contract to a construction company known to be incapable or unwilling to execute the work satisfactorily, yet situations frequently arise where departments can not publicly justify themselves in refusing to accept the proposal of an unqualified company. This condition appears to result from the ease with which almost any concern professing to be a construction company can obtain a performance bond.

"To the layman unfamiliar with the difficulties involved where a highway department is attempting to carry out a definite mileage on schedule, a financially strong surety is regarded as ample safeguard to the state. In view, however, of the delay and legal procedure frequently incurred by default, a corporate bond has often proved an inadequate and expensive form of protection. Some means is needed for minimizing the operating of irresponsible contractors on highways and for encouraging the growth of more responsible concerns.

"Most highway departments now have the authority to reject the bid of an irresponsible company, but in practical effect such authority can seldom be freely exercised. As long as irresponsible bidders can secure a bond and the public is willing to accept that bond as a guarantee of responsibility, the highway official will not be in a position to exercise his rightful authority. In other words, he can not judiciously refuse in many instances to award a contract to the incapable contractor while this practice of promiscuous bonding continues.

"The present situation is one which appears to have passed in a great measure beyond the control of bonding company officials and to have resulted primarily from the commission system of compensating underwriting agents and the freedom exercised by these agents in writing bonds.

"Agents are reported as receiving commissions amounting to as much as 25 to 35 per cent of the total premium. Local competition between the agents of different companies is apparently keen. Their primary interest is often manifested chiefly in securing a bond for the lowest bidder, not because he is competent, but merely in order to secure the compensation involved. This tendency has naturally resulted in heavy expenditures by the surety companies who have met increasing losses by increased premium rates. Within the last 20 years the cost of premiums has risen in some instances more than 1,000 per cent. The practice has apparently been to bond almost any low bidder and to let the increasing premiums cover the losses from default. The public has paid the bill.

"This situation could not occur in a truly competitive industry where the demand for a commodity is influenced by the prices charged. In the public bonding field, because of urgent demand, where work will proceed almost independently of a bond premium rate and because of a standard rate, it has been possible to increase the rate to a point where such increases mean millions of dollars annually to the public but which have not increased the net earnings of the bonding companies in proportion.

"If the mere payment of a high premium were the only element involved the matter might be of less concern to engineers and public officials, but a more vital factor is involved by the disruption of highway programs, delays in building and expense resulting from defaults.

"State highway officials can exercise an effective remedy by encouraging a measure of competition in the surety field. Such competition would tend to reduce bond premium rates, thus necessitating more judicious bonding of contractors, which is the main objective to be sought.

"If the surety companies can not devise a means of eliminating detrimental practices on the part of agents, and of

faithfully performing their stewardship to the state, the force of public opinion will eventually demand that their house be placed in order. Therefore it is proposed that before present conditions become more aggravated, representative bonding officials be invited to meet with representatives of The American Association of State Highway Officials and Associated General Contractors to devise, if possible, an amicable and co-operative method of relieving the present situation.

"As a means of enabling highway officials to ascertain responsibility of bidders with respect to a given project, various states have devised questionnaires designed to reveal the bidder's qualifications. These forms varying considerably in detail, require, in general, a statement of financial resources, equipment available, experience and personal references from bankers and public officials. From these the highway official is able to gauge more accurately the bidder's ability to perform a given project."

The sad part of it all is that the remedy is so simple. The business can be secured as easily as a good risk, as it can be as a bad risk. When the bonding companies learn that it is to their interest to see that the so-called lowest responsible bidder has the skill, integrity and responsibility, bearing in mind that skill necessarily means having a knowledge of costs obtained from first-hand experience, then the contractors will be protected, and the engineers will be protected and the public will be protected.

The foregoing paper by Mr. Helmers was presented before the recent annual convention of the Associated General Contractors of America.

HIGHWAY CONTRACTING AND ITS ILLUSIONS

By T. J. Wasser, Civil Engineer, Public Service Production Company, Newark, N. J., President of New Jersey Construction Association.

The Good Road movement throughout the country, advocated by the progressive type of citizens, fostered by the federal, state and county governments and financed by monies raised by bond issues and direct taxation, has produced an industry that statisticians say is second only to the agriculture of this country, which means that they talk about it in the millions and hundred of millions of dollars.

Contracting Looks Good

Why should it not attract men and capital? As there are several factors entering into the makeup of the industry, one looks for what he considers the most lucrative and naturally selects that factor having the game of chance connected with it, having in mind the possibility of large returns for the money invested, and therefore decides to become a highway contractor.

Two Fundamentals and Four Essentials

In former years, and not so long ago, road building was considered only a part of general contracting carried on by antiquated methods and equipment, with no respect for time. But what have we today? Highway contracting is a highly specialized business based on two fundamentals and four essentials, carried on successfully only with the use of modern type of machinery, the best grade of materials and handled without delay in the shortest possible time in order to insure a profit on the money invested.

Two Types of Contractors

Into this present field of highway contracting we have two types of contractors, the individual firm or corporation that was in the business when the modern hard-surfaced highway was first introduced and has progressed with the movement for modern highways throughout the country, many at great loss and expense, but financially able to weather the experience and today representing our successful highway contractors. The other, the inexperienced individual, firm or corporation who broke into the business in recent years with a vision of large profits, but who in reality had a lot of false ideas in mind. What are the results?

Effect of Newcomers

Through lack of knowledge or experience of the newcomer, work is generally underbid, competition destroyed, capital lost, the work delayed and the public that finances the work dissatisfied, due to being deprived of the use of the road for two or three times longer than that necessary to complete it.

Compare that condition with a job awarded to an experienced contractor with sufficient capital to complete, and who does complete, the work satisfactorily and on time with a small average margin of profit on the money invested (and not the large profits Dame Rumor would have you believe) and you have a general satisfactory result.

Protecting the Newcomer

How are you to protect the newcomer?

First—By showing capital and inexperience that large profits are an illusion.

Second—By establishing a standard, by comparison between the two types of contractors in order that the public may know.

Third—By making the standard of responsibility such that only after proven ability can a contractor enter into the competitive field of highway contracting.

Fourth—By obtaining the co-operation of those responsible for the conditions governing the design and supervision of the work.

Contracts for highway construction are awarded in sums up to a million dollars, the majority of contracts being valued at from $200,000 to $500,000. Naturally the percentage of profit that one is entitled to on such amounts is what attracts and the ease in which one can qualify as a responsible bidder is the contributing primary cause of so many failures.

Before going into the details, let me compare the two types of contractors referred to, because on the result of the comparison depends whether profits can be anticipated or failure assured.

The Two Fundamentals

The writer has previously stated that highway contracting was based on two fundamentals and four essentials.

The fundamentals are:

First—Transportation of materials.

Second—Construction methods.

In the former, the transportation includes the handling of the materials from the point of delivery of the common carrier to the site of the work at the point of operation and upon this alone may depend success or failure, all other conditions being equal.

In the latter, only the most modern arrangement of plant, operated at a uniform rate of progress will insure success.

The Four Essentials

In order to carry out these fundamentals, one must have experience, skill, organization and sufficient capital properly to equip and carry on the work with these four essentials; backed up with integrity and responsibility success is assured. Lacking in any one of the four essentials, failure will result and profits disappear.

Where Newcomers Come From

The newcomer into the field of highway contracting usually is any one of the following: A contractor experienced in another branch of construction, an individual or bank with money to invest, a former job superintendent who knows nothing but the field construction work, the individual with money and no knowledge of the business, or any combination of these.

How did any one of them come to attempt highway contracting?

Big Figures Attract

The writer firmly believes that the publication of news about the vast sums of money to be spent for highway construction is the primary cause. The reprinting and distribution of the figures by manufacturers of highway equipment to prospects, to increase their sales, have misled many to enter the business.

The eagerness of capital to participate is shown by the ease with which the inexperienced contractor can obtain funds until his inexperience demonstrates that the banker is directly in the highway contracting business.

A Plea for Sane Bonding

Why is it that keen executives who manage large successful bonding firms of this country do not strike out now and adopt a policy of conservative, sane bonding into which later they are going to be forced?

Inexperienced contractors can be made responsible bidders by the eagerness of the bonding companies to go on their surety, so easily that the bonding companies against their will sometimes get into the highway contracting business.

All of these unsatisfactory conditions could be avoided if the bonding companies had to do business only through permanently established agents, eliminating the broker that has no place of business.

Limiting Amount of Surety

Bonding companies should adopt a schedule of surety by which a limit would be placed on the amount of surety the company would assume the first time the applicant applies; for example, say up to $60,000. If the work was completed satisfactorily and the same applicant makes a second request for a bond the limit should be placed at, let us say, $125,000, after which, if the contract is satisfactorily completed, the bonding company should issue a certificate placing the applicant on the preferred or competitive list, which, providing his financial statement warranted it, would

class him as a responsible bidder for highway construction.

Troubles of the Experienced Contractor

Now let us consider the experienced contractor and note some of the unreasonable conditions in highway construction that he has to contend with. For example, in estimating on work, the contractor is required to assume all the elements of chance. I believe insufficient time is given to the preparation of plans and instructions to bidders and quite frequently proposals are prepared where an item for excavation is required also to cover clearing, grubbing, ditching, etc. Highway contracting is the only branch of construction industry that has to contend with outside interference, and that at the contractor's expense. I refer to maintaining traffic through the construction and the interference from public utilities, especially those with sub-surface structures. It is impossible for the contractor to figure what the above conditions referred to will cost him, yet the requirements of bidding demand that he take care of them.

The requirements for accurate work are more severe than in any other branch of the construction industry. For example, the preparation of sub-grade and setting of forms are such that no variation is allowed, yet frequent field errors occur which the contractor has to absorb and at times are very costly. The sub-grade is prepared with great care, yet it is impossible to produce a pavement of the exact thickness and crown as specified. Any variation in the thickness of pavement is always at the contractor's expense, whether it is over or under the specified thickness.

Materials and Transportation

Of all elements entering into the construction of a highway, the highway contractor is the only one that is required to furnish a surety guaranteeing to do something, most of which is beyond his control. For example, the specified requirements for materials in many cases are such that the contractor is limited to one or two sources of supply, the owners of which, together with the common carrier, may deliver the material promptly or when convenient, but the contractor must not only pay for delays but also guarantee the completion of the work on time.

Highway contracting confined to about nine months in the year, carries a burden more costly than the actual idleness, namely, the loss of an organization, it being necessary to reduce the forces during the inactive season. Due to changes annually in the organization, the abuse of the equipment under such change is very expensive and shortens its life, which is short enough under favorable conditions. Another feature affecting the life of the contractor's equipment is when radical changes are made from year to year in the design of the highways, thereby requiring new equipment to be purchased and the last year's equipment scrapped.

The contractor places the orders for material to meet the requirements specified; failing to meet the requirements the material is rejected, but who pays for the loss and delay? The contractor.

Delay from any cause whatever, such as labor troubles, stormy weather, rejection of material, inexperienced inspection, delay in delivery of materials, results in big losses to the contractor, inasmuch as all profits on the work were figured at a daily rate of progress.

Anything in the future that can be worked out between the contracting parties to reduce to a minimum the elements of chance will go a long way toward reducing the cost of highways.

In conclusion, I would say that the time has arrived for all parties interested in the development of modern highways to get together by conference and settle all questions that are involved.

The foregoing paper by Mr. Wasser was presented at the recent annual meeting of the New Jersey Highway Association.

METHODS AND COSTS OF MAKING TRAFFIC SURVEYS

By George E. Hamlin, Superintendent of Repairs, State Highway Commission, Hartford, Conn.

With the need for a more permanent type of highway surface, together with the demand for a definite program of road extension, has arisen the problem of surface type to be applied to any particular section of highway. Increased costs of construction have not been met by increased appropriations and there appears the necessity for a definite recommendation for each particular section of road to be built so that expenditures may be made to the best advantage, not alone for present use but for estimated or potential traffic during the life of the particular type of surface.

Factors Involved

This problem involves not alone the type of surface but the width of metal as well as of shoulders. In the design must be considered capacity for peak conditions due to seasonal variation and character of traffic, as well as traffic concentration for short periods due to local conditions such as a popular football game.

The design of the road surface and foundation must be based upon a definite idea of the amount, weight and concentration of the vehicular traffic in which must be considered an allowance for increase for the estimated life of the surface type.

Facts Essential to Proper Design

The increase in cost in this type of construction will show value received during a period of years, far in excess of that afforded by a surface designed too weak for its estimated life and increased use, with the consequent heavy maintenance and reconstruction charges.

It is of the greatest importance for the road designer and builder to obtain accurate data from which can be estimated the weight, type and increase of traffic for the necessary period. Mistakes have been made through a lack of sufficient knowledge of present and future conditions largely because the cost of obtaining this data seems excessive for its value.

Cost Negligible Compared with Benefits

When it is considered that the cost of operating a traffic survey party, fully equipped, for an entire year is only equivalent to the cost of construction of approximately one-quarter of a mile of modern concrete highway, and that the data obtained from this expenditure may result in large saving in construction costs through the elimination of poor design, it follows that reasonable amounts expended in obtaining this data will be returned to the community in value far in excess of such cost.

Traffic surveys cover conditions existing only at the time the survey is made, while transport surveys will furnish data for estimating future traffic conditions. Each traffic survey should be designated to be used in co-relation with future surveys so that data may be obtained from which highway transport may be estimated.

Forecasting Traffic

If a comprehensive survey is undertaken for a continued period of time and in the State is used as a factor, it follows that from subsequent surveys taken over short critical periods of time, curves can be plotted which will, to a fair degree of accuracy, determine potential traffic for a limited period of years.

A system of units for reporting traffic should be established, these to be multiplied by definite factors from which can be obtained estimated daily and yearly traffic from short period surveys.

Each community differs from others so greatly, not alone in type and character, but weight of traffic, that it is believed these factors must be established for definite zones rather than to be assumed for the country at large.

Many roads on the main thoroughfares throughout the country have practically reached their saturation point at this time. In fact, in some cases the number of vehicles now using the highways during congested hours has reduced the maximum capacity of the road which could be obtained with a smaller number of cars. This has been proven by actual census test.

New Jersey Experience

The New Jersey Commission has made very extensive counts covering highways entering Jersey City. The New Jersey Interstate Bridge and Tunnel Commission has developed a factor of 12.2 as the rate between daily and maximum hourly traffic. Roughly stated this would mean that the maximum hourly traffic is approximately double the average hourly traffic. It will be interesting to apply this factor in other sections of the country to see if this question is uniform in various localities.

A Guide to Proper Expenditures

A traffic survey is of value for the distribution of both construction and maintenance funds. Such distribution, however, should consider not alone the present demand, but the future need. It is as much a function of a Highway Department to develop the sparsely settled sections of a community as to take care of present traffic requirements. If actual present traffic conditions only are considered, the extension of a State highway system would be a future rather than a present problem.

It is not the purpose to detail at this time data to be obtained from a traffic census. This should cover every phase which is of value in determining traffic conditions both in regard to weight and quantity. Length of haul, type of commodity, and seasonal variation must be considered in making up the blank forms. Enough data should be obtained to deter-

mine the competitive value as against other forms of transportation.

Truck Scales

Scales of suitable size must be installed at strategic points for the purpose of obtaining actual weights carried on trucks of each capacity. No other method will determine the overweight per capacity or the tendency to overload the smaller trucks beyond their safe or registered load.

In the case of passenger cars, data must be obtained from which the average number of passengers per car, the average distance of trip and the pleasure or business use of the car is demonstrated. Stations must be placed at points where the traffic naturally divides so that not alone the relative value of any particular road may be determined, but the value of each section of such road. The location of these stations should be determined by men thoroughly familiar with the locality and with traffic conditions at each particular point.

Routing Parties

It is, of course, impracticable to establish a census party at each necessary station for continuous operation. It is therefore necessary so to route each party that they will occupy each station successively on different days of the week, so that weekly as well as seasonal variation may be determined. Each station should be occupied at least once each month and the number of parties will vary with this requirement and the number of stations established.

Each party should consist of not less than four men. On the more heavily traveled thoroughfares, it has been found that in order not to cause too long a questioning period, six men may be required to a party. Each party should be motorized to obtain satisfactory results, not alone on account of being able to change from station to station in the shortest period of time, but that necessary equipment may be with the party at all times.

Director of Survey

The survey, in general, should be under field charge of a director thoroughly familiar with all sections covered by the census. His duties should consist in keeping in close touch with each individual party through its chief so that decision in regard to new conditions may be made at once and data collected for tabulation as quickly as possible.

If each station is occupied once each month, each party will be able to take care of 28 stations, so that there must be one party for each 28 stations established. Each party should work a definite number of hours per day, these hours being varied at successive occupancy of the same station so that daily variation in traffic may be determined.

Arrangements should also be made to take a continuous 24 hour survey at controlling stations, thus giving an opportunity to transpose the 8 or 9 hour period into a 24 hour period on a proportion basis.

Scale Installation

Scales should be of the pit platform type, capable of taking the largest loads in operation on any highway. In practice it has been found that the 20-ton type with a maximum capacity of 28½ tons is most practical, it being possible in case of loads in excess of this amount, to weigh the front and rear axle separately and to combine the weights for a total load.

This method, by test, has been found to be satisfactory, providing the approaches are on a level grade. The platform dimensions are 9x24-ft. and with the proper concrete pit, the cost of the complete scale averages about $2,700.

Division of Labor

In operation, the parties function through a chief and three or five men. Two of the party take the necessary measurements of truck, tires, etc., and the third man takes the weights of both front and rear axle and interrogates the driver in regard to point of origin and destination, type of commodity, and regularity of movement. In the case of passenger cars, the observers obtain by inspection much of the required data and the driver is questioned only as to points of origin and destination and as to pleasure or business use of the car.

Public Relations

A sign clearly displayed, giving the purpose of the questioning is the greatest aid in eliminating time and useless questioning by occupants of the car. The next greatest asset is courtesy. Very rarely will an operator refuse to give the required information, recognizing its value in the increased efficiency of the road building program.

Newspaper publicity in the sections where the census is in operation is well worth while, as by this method, co-operation is obtained from the driver who realizes that a quick response on his part will aid traffic conditions.

Code Forms

Much of the tabulation is simplified if code forms are used, this also greatly simplifying the tabulation of the information in the office. After a short period of time, it is found that the code forms are as familiar to the men as the actual names themselves and very little reference is required to the code table.

Each car is entered on a separate card and becomes a permanent record when punched for tabulation purposes. It is possible with the tabulating machines now in use to obtain practically any information in regard to make, type, weight or other car or truck classification by passing the cards through the machine after adjustment has been made for the type of information desired.

Detailed Procedure

The taking of the data represents only a fraction of the work required. The cards collected by the director should be sent to the tabulating bureau at regular intervals. These cards are passed to operatives who transfer the written information to the punch cards for use in the tabulating machines. From the data obtained, charges and curves are plotted showing the various results obtained from the survey. These charts show hourly, daily, and seasonal variation of traffic as well as distribution at various times of the year.

After the first complete census has been taken, it is expected that stations will be occupied at critical points during succeeding years and that following the original curve, additional curves can be established from which can be estimated potential traffic at a future period.

Cost of the Work

Under labor conditions in the East, the cost of operating a census party, including transportation, salaries, expenses, and necessary equipment has been in the neighborhood of $9,000 per year. Light traffic conditions during the winter months and consequent reduction of party numbers has tended to reduce cost at this time. On the other hand, abnormal conditions of summer travel have increased the number of observers required so that the average is about that above stated. On the basis of 28 stations to each party, the cost per station should approximate $325 per year.

"Bottle Necks"

One of the greatest causes of traffic congestion is the so-called "bottle neck" point which automatically retards traffic at one particular location. The effects of this retardation can be seen for a considerable distance on either side of the point in question. A traffic census will develop interesting figures for comparison.

In many cases an expenditure of a small amount of money will result in the elimination of this condition and allow the traffic to flow regularly throughout the entire length of the road.

Traffic Peaks

In the design of any road, abnormal conditions due to peaks of traffic must be considered. In this connection, it may be interesting to detail a few figures concerning two of the major football games in New Haven:

At the Yale-Princeton game in 1921 on seven main highways entering New Haven 26,000 cars were counted. At the Yale-Army game in 1923 during the same period and at the same stations 36,000 vehicles were counted. On the Boston Post road 7,661 vehicles passed in and out of New Haven during the twelve hours from 8 a. m. to 8 p. m. In this period the maximum hourly traffic report showed 1,393 vehicles passing between 6 and 7 p. m. at Station No. 5, or at an average rate of 23 vehicles per minute. Of the total number of vehicles 2,500 were trucks, the balance being passenger cars.

On the highways where the point of saturation is nearly reached, a traffic study will often develop a solution of far more value than the small cost involved. It is not at all visionary to foresee that in the very near future, grade separation will be employed at crossings of important trunk lines and that new highways extending by, rather than through, the larger centers of population will be constructed, to be connected with such centers by a broad main highway.

Traffic flows in the line of least resistance and can be directed in this manner. In many cases, the proper direction, the elimination of congestion, and a limited amount of widening will increase the capacity of a road far beyond the proportionate cost.

Conclusion

In general, road building should be treated as an exact science rather than as an experiment. The facts are obvious when collected and tabulated. The cost is low compared to the results obtained. Traffic information is of great value in the designing room and is as necessary to proper design as determination of surface or grade. With this correct in-

formation available, possibility becomes an actuality.

The foregoing paper by Mr. Hamlin was presented at the recent annual meeting of the American Road Builders' Association.

ORGANIZATION, METHODS AND EQUIPMENT FOR SNOW REMOVAL

By Edward E. Reed, Assistant State Highway Engineer of New Jersey, Trenton, N. J.

Snow removal work in New Jersey was first considered in the winter of 1917-1918 when this country was at war. The purpose at that time was to keep certain roads open to traffic so as not to interfere with the truck convoys going from inland points to the sea-board for shipment to France. Fortunately, however, there was very little snow during that year and very little was accomplished. Some work was done on a small scale during the winter of 1918-1919 and the winter of 1919-1920. The real organization was first effected in the winter of 1920-1921 and this winter will make the fourth year for this intensive work in New Jersey.

The State comprises an area of 8,224 square miles and a population of 3,155,900. While it is a small state, it is thickly populated and its roads form important connecting links between New York and Philadelphia. In addition, the State is primarily a manufacturing or industrial state and considerable truck traffic passes over its highways.

The total highway mileage exclusive of city and borough streets is 17,120. The State Highway System comprises 726 miles or less than 5% of the total highway mileage in the State. The roads in this system, however, are important interstate and intrastate routes. Motor truck transportation is carried on over these roads during winter and summer. It was therefore considered necessary in rendering proper highway service to the public that these highways should be kept open at all times so that the loads could be moved with regularity and as economically as possible. With this in mind the snow removal organization was developed.

Organization

The following remarks refer to the organization in effect covering only those roads in the State Highway System or the detours which are kept open and maintained because of state highways under construction.

The organization is divided into two general headings, the office and field forces. The office force consists of a day and night force, each being on duty for 12 hours if necessary, and is subdivided into representatives of the administration, maintenance and equipment divisions. The duties of the representatives of the administration division are to provide telephone service, elevator service, and heat during the "wee small hours" when there is usually not much of this available. The representatives of the maintenance and equipment division keep in touch with their forces in the field.

It is the duty of the office force to keep in constant touch with the United States Weather Bureau for advance information of the approach of heavy storms. New Jersey, however, is situated in that latitude where it is difficult to tell in advance whether a storm will bring rain or snow. To overcome this feature our field forces telephone to the central office if it begins snowing before they hear from headquarters. The office organization is immediately assembled and contact is made with the different sections of the state in order to determine the extent of the storm.

The field forces are subdivided into the contractors' forces, state highway maintenance forces and state highway equipment forces. For snow removal work the state highways are divided into sections approximately 12 miles in length. For this year there are 59 such sections, 47 of which are assigned to contractors and 12 are handled by maintenance forces.

A map is prepared showing the sections which are to be opened by contractors' forces and the maintenance forces, the name of each contractor appearing on these sections. After these sections have been assigned, a conference is held between the contractor to discuss rates of pay and methods of operation which have come up in previous years, to govern which, it is necessary to adopt rules and regulations that will be agreeable to both the contractors and highway department.

A questionnaire is prepared and forwarded to each contractor giving the number of the state highway route and the terminal points of his section, and the numbers of the trucks asigned to him. He returns this questionnaire, giving the correct name of the company, the name of his superintendent, and the telephone numbers of the garage where the trucks

are stored and where his representatives may be reached at any time of the day or night, Sundays or holidays. A chart is made giving all of this information for ready reference.

Equipment

The equipment used on the contractors' sections consists of trucks received from the Federal Government from war surplus material. These trucks are used by the maintenance forces for repair and maintenance work. When this work is completed, they are sent to the Fernwood service station, which is a large garage and machine shop located near Trenton, where they are thoroughly overhauled and put in good condition for snow removal work. The scraper blades or snow plows are attached and these trucks are forwarded to garages in different parts of the State, located at points convenient to the different sections. These garages are selected by the contractors and representatives of the highway department.

There are 3 trucks assigned to each section. They are Nash Quads, Macks, Rikers, Heavy Aviations, F.W.D.'s and Packards. The equipment is kept in heated storage with the snow plows attached and the trucks are filled with ballast and jacked up to relieve the springs of the weight. This is done so that there will be no delay in getting out on the work when the snow call is issued.

The contractor is required to have 3 men on each truck, 2 drivers and 1 helper. This is necessary because when they start out in a storm, it may be necessary to be out 16 or 24 hours and this is entirely too long a shift for one man to serve without relief. With the men on the truck there is always relief available without holding up the equipment for one of the crew. The contractor has a superintendent in charge of this work and the men he employs are usually the men that he keeps during the winter in order to hold his organization together.

The 12 sections handled by maintenance forces are generally gravel roads that have not yet been reconstructed and the equipment which is used for gravel main tenance work is used for snow removal purposes. This consists of a 3 or 5-ton "caterpillar" tractor and 1 or 2 scrapers on each section.

In addition to the contractor's forces the maintenance division assigns one of its foremen to each section. The duties of the maintenance foreman are to assist the contractor and co-operate with him to open the road as soon as possible. He also keeps in touch by telephone with the Trenton office and advises of the progress being made by the field forces. The equipment division also assigns a mechanic to each of the contractors' sections and maintenance division sections. The duties of the mechanic are to see that the equipment is kept in proper working order and to make any adjustments or repairs in order to keep it in constant use.

This entire organization is handled from the Trenton office. If the information received from the United States Weather Bureau is of a definite nature, a snow call is issued. If no information is obtained from the Weather Bureau in advance of a snow storm, field representatives keep in touch with headquarters if it begins snowing. If it is apparent that the snow will result in a fall of 2-ins. or more, a snow call is issued and the contractor is notified to call his organization together at the garage where the trucks are stored for his section.

A record is made in the Trenton office of the time of this call. The contractor then calls back when his organization is together, but he is not authorized to go out on the road until we are satisfied that the snow is of such a depth to warrant removal.

The three trucks travel together up one side of the road in echelon, pushing the snow out to the side as far as possible. A trip is made to the end of the section and then a return trip is made on the other half of the road in the same manner. The purpose is to push the snow back far enough so that subsequent snows will not restrict traffic to less than two lanes.

It is absolutely necessary to call out the organization and have it ready so that the snow can be removed when approximately 2-ins. in depth and have the outfits continue removing the snow throughout the storm. It would not be effective if we were to wait until the snow had stopped before starting out.

When the outfits have cleared the road, a representative calls the Trenton office and reports this fact. He is then authorized to disband his forces, or if we have information of the approach of another storm, he is told to hold his forces in readiness. When an outfit is finally called off, a record is made in the office so that when bills are presented they can be checked with this record. A contractor

presents his bills for snow removal work after each storm.

This work done by the contractors is not done by contract but by force account and the rates paid are previously agreed to by the highway department and the contractors. The bills for the monthly storage for the trucks which range from $10 to $20 per month per truck are paid directly by the State Highway Department to the garage owner on presentation of the bills in proper form. No hand shovellers are permitted without first having the request O.K'd by the Trenton office and these are only used in cases of emergency where blizzards are encountered. Maintenance forces open the drainage ditches and structures as part of their regular duties after the road is opened.

In addition to the equipment mentioned above, for general emergency purposes we have 5 10-ton "caterpillar" tractors equipped with V-type locomotive plows stationed at certain strategic points throughout the State.

During the winter of 1922-1923, snow fell on 44 different occasions. On 16 of these occasions it was necessary to do snow removal work. Twenty-two or just one-half were recorded as traces, that is, less than 1/10 of an inch fell and snow removal work was not necessary. The snow calls issued during the various months were as follows: November—None; December—2; January—9; February—4; and March—1; making a total of 16.

The depth of snow-fall varied in different parts of the State. In the northern part, such as Sussex County, the total snow-fall was 61-ins. The least snow-fall recorded was 15.7-ins. at Sandy Hook. The average total for the entire State was 44.7-ins.

The length of the State Highways under snow removal during the winter of 1922-1923 was 698 miles. The total cost of this work was $223,908.76. The average cost per mile was $321, and the average cost per inch per mile was approximately $7.

The snow removal work done by the State has influenced the various counties, and most of the counties in the State now have a snow removal organization and follow methods similar to those followed by the State Highway Department, the idea being to get out on the work during the storm and to keep ahead of it.

The Highway Department of New Jersey has been able to keep the roads clear of snow and this highway service is appreciated by the traveling public as evidenced by letters and favorable newspaper comment. We would not be able to accomplish this result if it were not for the splendid spirit of co-operation existing among all of those connected with the work.

The foregoing paper by Mr. Reed was presented at the recent annual meeting of the American Road Builders Asociation.

ECONOMIC ASPECTS OF DAY LABOR CONSTRUCTION

By Arthur S. Bent, President, Bent Bros., Inc., Engineering Construction, East Fourth and Pecan Streets, Los Angeles, Calif.

In discussing with you this question it is quite likely I shall be unable to hold myself strictly to its economic aspect, except in the broadest sense of the term, because the consequences of its decision are far reaching and many sided and are not confined merely to the measure of dollars and cents. Indeed I am not sure this is its most important aspect.

Effects on Citizenship

For illustration let us assume for the moment that the study of the Reclamation Service now being made shall later indicate that the enormous amount of work that Department has been doing by day labor has cost far more than it could have been contracted for. Would it then be straining an argument to contend that the partial failure of this huge benevolent enterprise has been due in some measure to this excessive cost? And might we not legitimately follow through a chain of consequences leading far beyond mere money waste? Would it not be easy to show not only resulting poverty and distress among settlers, but discouragement, distrust and even disloyalty toward the Government, striking a blow at the very character of our citizenship in these areas?

Comparing "firm contracts" and "day labor" I believe it would not be hard to demonstrate that these two methods of carrying on year after year the huge construction program of this nation, are so radically different that their results must to some degree affect differently our national character itself.

Not a Hypothetical Question

The problem we are to consider is not hypothetical. All over the country today there is a growing tendency among public officials to do public work by day

labor. This is not confined to maintenance, or to minor municipal operations, but reaches to single major projects of great importance. River levees built by the federal government; highways built by states; dams and canals built by irrigation districts; asylums and hospitals by counties; schools and sewers and paving by cities—all by day labor.

The real causes of this tendency are not easy to determine, but the reasons given by public officials are quite simple and specific. Chiefly they are, first, "to save the contractor's profit," next, to permit of more elasticity in carrying on work—under day labor method the responsibility upon the governing bodies of knowing just what they are going to do and how, does not press heavily. Next, work can be started quicker. But back of these and other reasons lie basic causes which are not so easy to get at. Sometimes it is a desire for power and the support in authority, which comes from a large body of subservient employes. Sometimes it is just politics of the old sordid variety, less common now but not yet gone from public life. To some extent it is traceable to a tendency toward socialism. Sometimes there is genuine discontent with contractors, or distrust of them. And let us in fairness say that sometimes it comes from a sincere, if mistaken, impulse to save money.

Whatever may be the underlying causes, the tendency is unmistakably manifesting itself, and as construction men who not only are vitally interested, but who should be expert in their knowledge and their conclusions, we are considering the matter as unselfishly and honestly as we can and asking the public to review our findings in the same spirit.

A Question of Grave Importance

If as we believe, this is a question of grave importance, involving much more than our own interests, then it must be so by virtue of the magnitude of the construction industry, or its vital connection with society, or both, and so we may be pardoned for bringing up once more a picture of construction as we now see it and a suggestion of the part it plays in the life of the world today.

In Secretary Hoover's last Year Book this statement is made. "Construction in the U. S. in 1922 exceeded five billions of dollars, equalling the combined value of wheat, corn, oats, barley and rye; almost equalling the net operating recepits of all the railroads in the United States and exceeding by 50% the total exports of this country. Activity in Construction bears a close relation to general business conditions."

S. W. Straus in a recent White House conference said: "There is potential need for eight billion dollars worth of new buildings in the United States today. The nation's volume of buildings for 1924 will reach five billions, and all of this is just so much new capital created to contribute its share of Federal, State and city taxes."

Secretary of Labor Davis recently stated as follows: "More than eleven millions of our people are dependent for their living upon the construction industry and 22% of all the skilled and unskilled labor of the country is engaged in the building branch alone. Some 250,000 freight cars are required to handle the materials. Our building bill is $200 per year for each family in the United States." Mr. Davis concluded, "It is truly the chief barometer of the business of the country. When Construction gains, prosperity is with us. It is the great outstanding influence for good or bad in our financial progress."

Another author has recently referred to construction as the "Big tool of mankind," and says "It has always been the best means of expressing the impulses underlying civilization."

Evidently construction contributes heavily to the tremendous buying power of our people and the savings banks of the country reflect to a remarkable degree the activity of this field. Construction is truly the key industry which unlocks the rest.

The Facts are Impressive

The cold facts are impressive. About 30% of the nation's wealth is produced by construction and it absorbs 60% of our national savings. Some 3,000 other industries are dependent upon it. Over 90% of the iron, copper, lead and zinc we produce is consumed in construction. It is simple truth to say that construction precedes and underlies all human development. "Everywhere the spirit of the builder hovers over the earth." Everywhere he is ceaselessly shaping the amazing structure through which human life functions and finds opportunity and happiness—building the highway over which it is travelling to its ultimate destiny.

Two Fundamental Questions

Now two fundamental questions next present themselves.

First, has the evolution of this tremendous activity which touches so vitally every human life, developed an adequate specialized ability, either executive or technical? Second, is that ability essential to its orderly progress?

If I could show in one amazing panorama, merely the physical problems which are being solved right now by the master constructors of the world, what an impressive answer it would be to our first question! What stupendous difficulties are being met, what marvelous works are being wrought! Great subways burrowed beneath the rivers and railways and buildings of New York, factories whose deep foundations are crowding back the Mississippi river with its tidal sweep of over 30 feet; concrete chimneys 300 feet high, 20 ft. in diameter, built entirely upon the roof of a power house; huge dams thrown across mountain gorges in the high Sierras while torrential streams flow uninterrupted; railways hung like spider threads along sheer cliffs and spanning mighty rivers; docks and seawalls that make good the challenge "thus far and no farther;" subaqueous conduits that lie on the ocean's bed and towers that pierce the sky; aqueducts traversing deserts and ranges and lakes; highways through swamps and under mountains; buildings that tower in safety and beauty 50 stories above the city's streets; all of this and much more our flash light would reveal and upon the throttle of this mighty engine of modern civilization, rests the competent hand of the general contractor.

Is the General Contractor Needed?

Let us look him over a bit before we consider whether he is really needed. He is the product of evolution plus personal ability and character. Slowly step by step he has climbed a hard road. He has had many downfalls, but he has learned much and paid with *his own money* for every lesson. Through *much experience* he has accumulated knowledge which can come in no other way, and he has acquired precedent to guide him through all new difficulties. He knows what tools will best work out his plans and how to use them. He has developed a keen judgment of men and their fitness and through his acquired ability to guide and inspire them he has built up a specialized and dynamic organization. Along with his skill he has developed integrity and responsibility so that *he absorbs within himself* the consequences of such mistakes as he may make and even such misfortunes as befall his work. He delivers the goods, the kind he promised at the price he agreed. He has rightly been called "civilization's big tool."

The Politician as a Substitute

Now who do the advocates of day labor ask us to take in his stead, for handling the 5,000 million dollars we will put into construction this year? Why, a politician, placed in office by a campaign in which his ability as a construction manager was not even remotely considered. He holds that office for a limited time until a new but similar official may take his place. He has no organization, no plant, no experience and frequently so little executive ability that the business world has passed him by, and public office is the best job he can get.

This official so poorly equipped that he would never undertake the work with his own capital, if he had any, says to the city or to the state, "Let *me* have this ten million bond issue and I'll build the highway or the sea wall or the aqueduct or the city hall, and save you all the contractor's profit! True I have no financial responsibility but I want to try it anyway. I have had no experience. I never undertook an important project of any kind and I admit that probably no contractor would want me as his manager for the job. But there's no reason why I can't hire the same men that he hires and get as good foremen and superintendents as his, and buy the material just as cheap. That's all there is to it. Then too the inspection expense will be nominal because nobody will cheat, and the engineering will cost much less because we don't have to get our plans ready in advance, we can start and then work them out as we go along. It is true I only *think* I can do all this, and if I miss my guess you will have to foot the bill. I can't give you any guarantee. Of course I don't propose to put up a bond. I couldn't get one if I wanted to, but—let's go!"

Now does anyone really question the proper choice between these methods from the standpoint of economics, which we are discussing? Can any of us doubt the pernicious effect upon the morale of our people, of this phase of Socialism? And is anyone really ignorant of the inevitable answer which history has already given?

Some Day Labor Work Essential

It is a commonplace to say that we all recognize the propriety and necessity of a certain amount of day labor work. Many emergencies can best be met by this method. Most maintenance work should be so carried on. And there are rare cases where the conditions indicate it for major operations. But in spite of such notable instances of successful construction as the Miami Conservancy District and the Los Angeles Aqueduct, the prosecution of public work by day labor has been a long story of waste of public money and the development of inefficiency. This is such common knowledge that I shall take your time with only a few examples, and moreover shall confine myself to my own observations.

Day Labor Highways in California

The state of California had a most significant experience in building highways by day labor, which is fairly illustrated by an excerpt from the report of the United States Bureau of Public Roads published in 1920. This shows from a study of 20 California highways, 10 of which were done by contract and 10 by the State's forces, that the contracted jobs exceeded the engineer's estimates by 39% while the day labor jobs exceeded the engineer's estimates by 193%.

In the joint report of the two great California Automobile Clubs may be found the statement that of 300 highway jobs done by day labor, and amounting to seven millions of dollars, the State's accounts showed unit costs on only five jobs. On two of these five the State first called for bids and rejected them on recommendation of the State Engineer who then undertook the work himself. The record shows the following figures:

	Engr's Est.	Contr's Bid	Actual Cost to State
Excavating	.55	1.10	1.17 per cu. ft.
Concrete	4.50	7.50	10.38 per cu. yd.

In totals this means on the first job a bid of $117,000 and an actual cost of $160,000 or a loss to the State of over 37%, and on the second job a bid of $43,000 and a cost of $81,000, or a loss to the State of almost 90%.

With such facts within their knowledge *what shall we think were* the reasons that led State officials to continue this method to the extent of $7,000,000. worth of highways; and were their reasons typical? It is gratifying to add that the present California administration went into office under a pledge to stop this reckless waste and to carry on its public competition and firm contracts protected by surety bonds.

Other Examples

The Gila Dam in Arizona was estimated to cost $800,000. It was built by day labor, without change of plan at a cost of nearly $2,000,000.

A county engineer of Northern California made the statement to me that during his administration practically all of the highways built by day labor ran 20% above the bids received for the same work and moreover that inspection was poor and labor inefficient. Also that in the few cases where cost keeping was attempted at all, nothing was allowed for equipment or its depreciation.

On Strawberry Valley Project, Utah, in 1915, contract prices were 30% below Federal day labor costs of the previous year. On King Hill Project, Idaho, in 1920, 21 and 22, under day labor methods, costs exceeded estimates by nearly a million dollars, concrete running from $36.00 to $48.00 per yard. Black Canyon dam, Idaho, now under construction, will run approximately $600,000.00 in excess of estimate. Malone dam, Klamath Falls project, 1922, cost approximately 30% more than similar work contracted on same project in same year. I could fill my allotted time with illustrations, big and little, of the waste of public funds on day labor construction. The taxpayer everywhere comments on this waste, and has his sarcastic joke about it. The story is written too plainly to be misunderstood. But let me add a word or two from experts, who are disinterested.

What State Highway Engineer R. M. Morton has to say on the subject of day labor versus contracts on public work is the view of a successful engineer of wide experience. "We have no conviction," he says, "that day labor work generally offers a means of saving money. We know that it increases the overhead expense and by scattering the energies of the administrative officials detracts from the quality and quantity of supervision given to contracts."

Wm. Mulholland widely known as the great engineer who built the Los Angeles Aqueduct by day labor recently wrote: "In the case of ordinary large works where plans can be definitely prepared, *it would be folly* to discard the customary method of employing the contractor. It is my firm belief that the proper method from a business standpoint is to accept the firm offer of the responsible and experienced contractor, thus definitely de-

termining the public's liability and putting the responsibility where it belongs, upon a concern which makes construction its specialized business."

Highway Work by Day Labor

Capt. Herbert Nunn, former State Highway Engineer of Oregon, after handling seventy millions of highway construction in six years, recently said, "I have found it impossible to do day labor work at a saving to the taxpayer."

F. H. Joyner, for many years Highway Engineer of Massachusetts and later Chief Engineer for the Los Angeles County Highway Commission, was called in by Arizona to study and advise upon its great road building program. I condense from his report:—"Whether it is best for a state to do its work with state owned equipment and state employed superintendents and laborers, is a question which in its broadest significance extends into the very foundations of our government. But considering only its economical aspects, a few facts stand out clearly. The average man expects an easy job when working for the state. It takes months under good supervision before he can be made to give the state the same service he would have given the contractor on the first day. Politics in some form is ever present in public work, and many men are employed not because of fitness but because of hidden pressure which cannot be denied. It is almost certain that day labor work will exceed the contractor's price by more than his profit and furthermore there is always present the danger that the engineer will close his eyes to defects in his own work which he would never permit from a contractor. There are examples of that sort in Arizona roads today. From many years of direct supervision of public work I feel that public bodies face *certain fundamental handicaps* that make it practically impossible for them to compete with the contractor in either cost or quality and I unqualifiedly recommend to you contract work."

The Los Angeles County Board of Supervisors after much experience under honest administration and conditions more favorable than the average, has disapproved the day labor method of doing public work and the chairman of the Board recently wrote:

"Our policy is to let all of our important work by contract wherever it is possible to prepare plans for bidders. We believe it is the sound and economical way to handle construction because it definitely fixes the obligations and responsibilities of the owner. If the work is let to responsible and experienced bidders backed by surety bonds the interests of the owners and the taxpayers are fully and definitely protected. *We do not believe it is economical to handle large works by day labor because of the impossibility of getting the same efficiency the contractor does* out of his trained organization and his specialized equipment."

Successful Contractor Must be Efficient and Economical

Now these important testimonials gathered only from many in my own limited experience are the expression of a situation which has been demonstrated over and over again. Day Labor work never has and never will develop the full efficiency and close economy which are the very heart of every successful contractor's history. And moreover, I make the assertion, not carelessly, that a competent examination of even the most conspicuous examples of apparently successful day labor undertakings in this country, would probably reveal not only an unnecessary cost but the further fact that the engineers did not hold themselves to the methods or standards they would have demanded of the contractor.

I also emphatically deny the soundness of the familiar argument for day labor, that it removes the incentive for slighting and insures better quality of work, and assert from my observations that just the opposite is true. We contractors in all lines of construction are constantly held up to the details of meticulous standards and specifications which no engineer or architect imposes upon himself. The engineer has no one higher in authority to criticize his own work. This is not a proper basis for public construction.

If Plans are Not Ready They Should Be

Neither will the public mind concede much favor to the other chief argument, that day labor permits the engineer to enter upon the work without the necessity of first fully preparing his plans. Great emergencies may occasionally justify such procedure, but as a method it is improper and unsound and leads to careless estimates and increased costs. It would be as proper to allow a contractor to plant the job one tool at a time as his need arose, as it is for an engineer to enter upon it before he has made the ful-

lest possible study and worked his plans out to completion.

Lack of Responsibility

But the fundamental and glaring unsoundness in the day labor method of expending public funds lies in the utter lack of responsibility back of the estimates and hopes of the officials in charge. It seems axiomatic that the taxpayer is entitled to assurance as to the ultimate cost of public work. The best of intentions and the most honest efforts on the part of officials are a poor substitute for guaranteed costs, and financial responsibility. The taxpayers of the country would not knowingly put this option into the hands of the ever shifting stream of politicians who pass through our public offices.

Recently a large irrigation district dam was finished by a bond issue, and the trustees, persuaded by their engineer that he could "save them the contractor's profit," turned the construction over to him on a percentage basis. But when they went into the market with their bonds, the underwriters refused the issue until the district had rescinded its deal with the engineer and had let the work to an experienced contractor whose firm offer was backed by a surety bond. Why? Because it is manifestly unsound economics to create a public loan for which the security or collateral is not definitely set up. When a bond issue is expended on day labor construction, the purchasers of the bonds have no assurance whatever that the money they are providing will create the promised collateral, and our history is notorious with wrecks in proof of this.

Day Labor Costs Generally Unknown

When public works are built by day labor the taxpayer very rarely knows the actual cost. Such statements as are made in answer to public demand are seldom a true picture. Overhead is not fully charged; equipment is shifted from other departments without charge; automobiles are used without charge; equipment is credited at the close of the job at a price above its actual salvage value; repairs of equipment are charged elsewhere; and telephones, telegrams, trips, postage, automobile supplies, general office work, depreciation are omitted or charged to general accounts.

If public officials really do make savings in construction work, why are they not eager to publish full reports which will stand the test of expert auditing? Why is it so universally difficult to dig out the real costs of such work from your city hall or your state capitol? Why do public officials always resist the adoption of state laws which would bring their construction costs fairly into public contrast with contractor's bids? It was only after years of struggle and defeat that in California we finally secured quite recently the adoption of a law which requires public officials to file upon completion, sworn statements of their day labor construction costs and to include therein repairs, insurance, transportation, rentals, depreciation, and all other costs entering into the work. Also to set forth the original estimate of cost, together with the bids, if any were taken, and a list of the publicly owned equipment used on the work and any changes in the original plans and specifications. Why was this wise, wholesome bill strenuously resisted? Isn't it certain that any public official, who really affected savings by his construction department would eagerly welcome publicity therefor? Yet quite generally they oppose all efforts to check their costs—costs which are nearly always hopelessly buried in books of general accounts.

May I digress a moment to illustrate what we mean when we talk about the value to the public of responsibility. A few years ago a middle west city voted a bond issue of about three million for a new water supply, and after some opposition from day labor advocates, let the work to six different contractors. The entire work was efficiently put through without default or delay, and within the money, but every one of the contractors lost heavily. The work actually cost three and a quarter millions. Was the contractor in this case a liability, or was his guaranteed cost an asset of vital importance to that community?

Need for the Specialist

The whole question is, does society need the specialist? Does it need the financial ability and experience of the successful banker, or shall we let casual office holders manage our monetary institutions? Do we need the trained railway executive, or shall the government operate our great transportation business with government employes? Do we need the men who have developed and manage our telegraph and telephone systems, or shall these be entrusted to the Democrats this year and to the Republicans next? And are the office holders of this

country the proper agency for managing the nation's vast construction program or do we need the contractor?

We believe society does need this man who builds up a great fabric of experience and specialized skill and organization, and holds it ready for responsible public service. We believe he is the orderly development of a sound economic system from which desirable conditions flow. Then let us not begrudge him his legitimate rewards—meager enough on the average.

Contract Method is Sound

The contract method is time-honored and sound. It is based upon well established economic truths. It's competition develops low costs and enforces high efficiency. It furnishes the guarantees and responsibility upon which the safe financing of construction projects must rest. Such evils as it has from the public's point of view are not inherent in the method. They are solely the result of the failure of owners to demand skill, integrity and responsibility in their contractors.

Day Labor Fundamentally Unsound

But the day labor system is fundamentally unsound. It breeds dangerous politics, encourages inefficiency, lowers construction standards, develops extravagance, decreases production, destroys individuality and lets loose that spirit of disloyalty to duty which notoriously during the war spread like a plague over the whole world. We all need the spur of competition. We all need to feel the pressure of definite responsibility. We all need the rewards of individual initiative and effort. America's splendid and amazing career fairly rests on that foundation.

Listen to the words of that discouraged prophet of day labor and communism, Leon Trotsky, as they appeared recently in the Literary Digest. "Our nationalized industries, even those working under exceptionally favorable auspices and well equipped, all are working at a loss. Our administrators and directors are not real masters who attend to every little detail, who watch everything, who save every minute of time and every cent of money, who work day and night caring for the needs of our plants." The same false theory upon which day labor rests has benumbed the great soul of Russia and not even her vast resources, greater than our own, will restore her.

A Tribute to Private Enterprise

Now listen by contrast to the stirring words of the President of the Chamber of Commerce of the United States, Julius H. Barnes—with which I close:

"It is the *American conviction* that private enterprises and individual initiative are very precious things in national life, which translate themselves into national progress.

"Consciously or unconsciously, American industry knows that its peculiar philosophy which stimulates the effort of the individual through assurance of a fair field and a secure reward for superior service, has become the mainspring of American accomplishment, and we will not permit unchallenged the loud-spoken claims of those who would write into the American structure, principles destructive of individual incentive and effort.

"Socialism leads to the easy theory of *public service rendered without account of cost.*"

"We should not remain silent when theorists in public life propose to displace the sturdy philosophy of individual accomplishment, with the easy social theory of the care of the State, *without that responsibility.*

"If we can read intelligently the lesson of our National progress, a progress which after all is only the aggregate of individual effort stimulated by fairness of opportunity and sureness of reward, then America may face the future without misgiving."

The foregoing address by Mr. Bent was delivered at the recent annual meeting of the American Road Builders' Association.

DESIGNING SWIMMING POOLS WITH REFERENCE TO OPERATION AND SANITATION

By Jack J. Hinman, Jr., Associate Professor of Sanitation, University of Iowa, and Chief, Water Laboratory Division, Iowa State Board of Health, Iowa City, Iowa

The subject of swimming pools and swimming beaches is receiving a considerable amount of attention nowadays from civic bodies, schools, clubs and kindred organizations. The desirability of providing safe and supervised places for the practice of the art of swimming or for mere play in the water is a thing which is readily appreciated and as a result a considerable amount of money is going into swimming pool construction

in an area such as that of the State of Iowa.

Data on Operation and Sanitation Lacking

Most of the work of the design of the pools has fallen to the local city engineer, the local architect, or to some other person who might be expected to be sufficiently familiar with the general type of construction into which tanks fall so that he might safely be entrusted with the work. Frequently the person selected tries to get information about the design of pools from the engineering papers or from trade literature, and he finds some material there. Unfortunately a goodly part of the material that he will find in the magazines available is not good material—at least it is not good material from the standpoint of operation and sanitation.

Not Just a Tank

The data to be found in these papers concerns chiefly the excavation, the reinforcement, the expansion joints, and the concrete shell. In other words, the articles are about the very parts of the work with which the engineer is most familiar, and on which the competent man is not so very likely to go wrong. But the swimming pool is something more than just a tank. It is not just a place to store a lot of water. It is a place designed for a very special use, whether it be an indoor natatorium or an outdoor one.

Design Features

The purpose of this paper is to explain why the ordinary tank is not a satisfactory swimming pool, and to mention some of the features which should be taken into account in the design of this type of equipment.

To begin with, we will admit that the basin should be tight, that it should be designed with the expectation that the temperature in indoor pools will range from a winter temperature to at least 85 degrees Fahrenheit, and that the walls should be designed so that the basin may stand full or empty with ample safety. The pool should drain completely and reasonably quickly without backing up of water in the sewers.

Dimensions

Now about dimensions: The minimum length pool in which athletic record may be made is 60 ft. Therefore this is the minimum length except under unusual conditions. Five foot swimming lanes are required and therefore it is a good idea to design the width of the pool so that it is in multiples of five feet.

The most satisfactory depth range is from about 3 to 7½, 8 or 9 ft. Where young children in any number are to be among the patrons, the 3-ft. depth may with reason be lowered to 6 ins. or even to zero. There is no necessity for a great area of deep water. To be sure, there should be deep water at the point where divers will enter the water, but there is no need for water over 4½ to 5 ft. deep for the rest of the swimming.

Too Much Deep Water

Indeed the greatest fault with most of the pools in use today is that they have too much deep water. This is particularly true of the large outdoor pools.

Deep water means increased water capacity. That means uneconomical design, for the water must be paid for and in many cases it must also be heated. More important than this, deep water restricts the use of the pool. Most people who use a public pool are not able to swim well. At most, they paddle around a little. Many never take their feet off the bottom. If there is a large area of deep water, these people who constitute the bulk of the patronage are herded together in the shallow end of the pool and are crowded together so that they do not have ample room and are subject to less sanitary conditions than would be the case if they had more space.

The Shallow Area

About 90 per cent of the area of a large public pool should be shallow area, that is, the water should be 5 ft. deep or less. In a small pool, nearly the same area of deep water as in the larger ones is necessary for the divers. However, an area of deep water across one end of the pool and about 10 to 15 ft. wide ought to be ample. Where springboards or towers are used, the deepest point should be below the place where divers from the tower or springboard will enter the water.

I have talked with a number of pool operators about desirable depth of water and in every case they have agreed to the reality of this need for a very large area of reasonably shallow water. The owner of one of the largest pools in the country told me that he planned to fill up his pool to such an extent as to fit it better to serve his patrons. Our fine Camp Dodge pool has by far too much deep water area. When it is in use by

the people who come out from Des Moines to swim, the bulk of the patrons are restricted to one end of the tank.

College pools and others that are to be used for contests, meets, and so on, may with reason have a larger proportion of deeper water, but since most of these pools also are used for swimming classes, the deep water area should not be a great deal more extensive.

Location of Deep Water

The deep end of the pool should be the end away from the entrance to the enclosure or pool room. The dressing rooms and baths should be located at or near the entrance. This arrangement will tend to keep poorly qualified persons from getting in the way of divers, and will lessen the danger of accidents through such interference, and also through non-swimmers falling or being pushed into the deep water. The scheme of putting the deep water area in the center of a large pool has much to recommend it. It may be assumed that only the strong swimmers will get out to the diving platform and tower in the center of the pool. Occasionally some swimmer will reach the platform after a fatiguing effort and will be afraid to attempt the return trip, but of course life guards should be on the raft or platform and would help the swimmer back to safety if requested.

Scum Gutters

The second error of construction in point of frequency is the failure to provide scum gutters entirely surrounding the pool. Some of the companies getting out pool literature apparently overlook this essential feature, and advise merely surrounding the basin with a pipe life rail. A life rail of some sort is essential to the safety of the individual bather, but it is better to use a combined scum gutter and life rail than a mere pipe. The common commercial types of scum gutters are cast so that the lip of the water channel fits the hand and provides an excellent hand-hold while the channel itself forms an expectoration and overflow trough, and a passage through which all surface wastes and dust may be carried away to the sewer.

Flushing Floating Matter Out

Dust and collections of floating matter in many cases may be flushed away merely by raising the water level and letting the overflow carry it into the scum gutter and so on to the sewer. This floating matter is unsightly and difficult to remove when the gutter around the whole pool is not provided. I have seen outdoor pools where it was necessary to attempt to bail out the dust, dead frogs, grass that had blown into the pool, and similar debris, by the use of a bucket. It was a time-consuming and imperfectly successful job. Yet in one of our foremost engineering journals the designer of that pool recently described the overflows as being ample and gave them the chief credit for keeping the pool in a satisfactory state, with only secondary mention of the chlorination boat—the thing that actually did the work.

Much of the material discharged from the noses and throats of the patrons of the pool will float, and will collect at the point where the dust gathers. The sooner such material goes down the sewer, the better, for it is potentially very dangerous. Most pool operators try to see to it that the bathers spit into the scum gutters, where there is one. Others simply say, "Do not spit in the pool." But the man who is in the middle of the pool must spit somewhere when he takes aboard too much water and he can't take the time to come clear over to the edge in such an emergency. When a scum gutter is provided, however, the bathers will use it as much as they can, and every bit of dangerous matter that can be kept out of the pool water should be kept out by all means.

Of course the scum gutters should drain quickly and completely. I know one pool in the state where there are beautiful scum gutters but where there is only one working drain on a side. This is not ample. The gutters are partially filled a good deal of the time. Every now and again a wave comes along, strikes the wall, overflows the gutter, and carries back a part of the contents into the pool. But even here the scum gutter gets rid of a lot of dangerous wastes from the bodies of the bathers.

The Runway

The next thing to be spoken about is the runway. Many of these are entirely too narrow; many of them are made of material that becomes very slippery when wet or which is not easily kept clean. The greatest trouble comes in the way that the runways are pitched to drain. They ought, of course, to drain away from the pool sharply enough that a bead will not need to be put on the pool edging. In the pool I mentioned as having a poorly drained scum gutter

there is still another serious error. The drainage from the runways is led to openings that carry it down into the scum gutter, and subject it to danger of being carried out into the pool. The runway drainage carries much dirt and a lot of very objectionable bacteria, and it also ought to reach the sewer as soon as possible.

Personally, I like to see a raised edge about a foot wide and about 6 or 8 ins. high all around the pool. This definitely separates the runways from the pool, prevents drainage of all sorts getting in and allows scrubbing and flushing of the runways without any possibility of the wash water being carried over the edge. On account of the possibility of tripping over the raised portion, it should be lined or marked so that the raised edge will be quickly noticed.

Beads on the edge of the pool make it hard for swimmers to get a suitable start in races, since the foot must be tilted so that the toes are raised. A square corner rounded at the edge with a curve of short radius is the best type of edge from the swimmer's standpoint.

Height of Room

The height of the room in which an indoor pool is placed is an important matter. The old type of dark, basement pools is passing out of existence. They were neither attractive, nor easily taken care of. Nowadays the greater number of pools are housed in large rooms with plenty of window space or with skylights to supply illumination during the day. The fact that the air of pool rooms is saturated with moisture calls for special waterproof finishes and the elimination of iron fixtures as far as possible. The iron fittings rust and cause stains on any light colored substance over which flows any water that has condensed on or come into contact with iron.

The height of the pool room should be at least great enough that divers from the springboard are not endangered. About 12 to 15 ft. are needed between the top of the board and the ceiling.

Ventilation

Ventilation of a pool room is not easily accomplished by means of windows alone. The wind blowing into the room is likely to carry a great deal of dust, and in time of cold weather it is likely to cause undue condensation of the moisture from the air of the room and also to render regulation of the temperature very difficult. Some system which will allow adequate ventilation without recourse to the windows is recommended.

Visitors' Galleries

When the spectators are allowed to move about on the runways where the swimmers are, there is bound to be more or less tracking of undesirable dirt into the enclosure, and the consequent carrying of the dirt into the pool on the wet feet of the bathers. In one of the Ames pools it was found to be very difficult to keep the pool water in satisfactory condition. Soil bacteria were decidedly in evidence and the reason for the condition was not realized until an inspection showed that a considerable number of persons in street shoes had been in the habit of going to and fro on the runways. Arrangements were made to stop this practice and the pool could then be kept in a satisfactory state. Visitors' gallleries, grandstands and similar places should be provided and definitely separated from the swimmers' enclosure.

Pool Lining

Everyone realizes, I suppose, that the lining of the pool should be of the smoothest, most impervious material that can be used in view of the amount of money available. The lining should also be as white as possible. The white smooth surface is easiest kept clean, and by reason of its apparent cleanliness is most attractive.

Marking

It is desirable to mark the walls and the bottom of the tank with dark lines adapted to the use to which the pool will be put. In tile-lined tanks, the dark lines may be put in of dark green, or black tile. In general, the lines that are most desirable are swimmers' lane lines. These lines should start well above the water's edge and be continued without break for the entire length of the tank and up to the corresponding height at the other end. Using these lines, the swimmer can keep within his lane whether he keeps his head above the water or swims face downward with his eyes open under water. Additional lines for water basket ball and water polo, and the line on the tank showing the jack-knife limit, 6 ft. from the end of the springboard, are desirable. It is desirable, also, when possible, to show the distance from one end of the pool to the other. This may be done by placing a small mark at every foot, with every fifth or every tenth foot numbered. These marks are useful in watching the plunge

for distance, and are helpful at other times. Signs about the pool showing the depth at definite points are well worth while, as they may prevent persons from diving into shallow water, or, on the other hand, going in beyond their depths.

Clear Water

If the tank is kept filled with clear, colorless water the floor of a white-bottomed pool should be very easily seen. This is exceedingly adantageous. It enables the life guards to keep a more efficient watch on the bathers and prevents the accidents which may result from a swimmer sinking and the fact not being noticed until too late. Of course a thing like that is not very likely to happen when the pool is not crowded, but when the pool is crowded the life guards have their hands full to keep order and to watch the swimmers who are in plain view. If the water is not clear, or contains enough iron to cause a turbidity after it has been aerated, filtration is necessary to keep the pool in a reasonable state of clarity.

Indeed continuous recirculation and refiltration are desirable for the purpose of keeping a pool water clear and in suitable condition from the standpoint of appearance, as well as an aid to retaining the water in a sanitary state, though filtration alone is not regarded as an ample protection. The heating and aeration that pool waters get cause a large part of the gases in the water to escape. Some of the calcium bicarbonate breaks up, the normal carbonate precipitates and then we have a whitish turbidity due to the precipitate. This condition is one which is most usually found in the indoor pool where a hard water must be heated. The calcium carbonate has a bad way of cementing the sand grains of the filter and so rendering the filtration less satisfactory.

Purification of Pool Water

On account of the shortage of time I do not want to go into the matter of purification of pool water in a detailed manner. It can be shown that refiltration and recirculation of pool water is desirable from an economic consideration. They allow pool waters to be used for a much longer period of time and so save in the first cost of the water, the heat necessary to bring the pool of water to a usable temperature, and besides this, they lower the turbidity, and keep it down in spite of the tendency for the carbonate decomposition to make the water turbid after use. Filtration removes bacteria but not to a sufficient degree as ordinarily practiced. It must be supplemented by some other means. This means the use of some germicidal agent.

Germicidal Agents

The common germicidal agents are copper sulphate, chlorine (either as the liquified gas, or as the hypochlorite of calcium or sodium), the ultra violet rays or ozone. With the last-named process I have had no experience. I am conducting some experiments on the ultra violet rays at the present time. My experience with the use of chlorine has been successful, although the chemical has to be handled with discretion, and persons are apt to claim that they can detect the odor of the chemical when it has not yet been used. Personally, I prefer the liquified chlorine as being susceptible of more accurate and more workmanlike control. It is more expensive to install and operate apparatus for gas under pressure, but the gas does not deteriorate on storage as the hypochlorite does, and the apparatus, which must be handled with care, will stand up well if given a chance. Copper sulphate has some germicidal powers but is most useful in keeping down the growths of algae or water scums which frequently bother the operators of open-air installations.

Removing Fine Deposit

A certain amount of dirt, lint, hair and so on will settle to the bottom of the tank after a time. Although this material is very offensive in appearance, and looks very black, yet it is only a very thin layer of fine powdery deposit. It is not readily drawn toward the outlet during recirculation, and when it is attempted to sweep it toward the outlet by means of weighted brooms, it rises into the water and dissipates, only to fall down again when the currents have subsided. Then it looks just as bad as ever.

This dirty deposit may be removed with a sort of vacuum cleaner arrangement especially designed for such work. The water which is removed by the tool from near the bottom of the pool may be deposited either upon the top of the filter and the deposit strained out, or run into the scum gutter and the water and dust run together to the sewer. Whenever a new pool is constructed some arrangement should be made to take care of these dirty-looking sediments. Their removal in an indoor pool with white

tile lining is quite a bit more important than in the out-door pool where they are not so noticeable. The dirt is very likely to make swimming in the pool unattractive.

Infective Material

From the standpoint of sanitation, the material in the pool which is most likely to cause disease consists of the fresh secretions newly thrown off from the bodies of bathers. Some of the organisms that we fear the most are very delicate and highly specialized. They do not adapt themselves well to unfavorable conditions. Lower temperature and less abundant food than they find in the body constitute such unfavorable conditions. Among these fragile organisms are most of those that cause infections of the respiratory tract. The organisms that cause intestinal diseases such as typhoid are more resistant—though they too soon succumb in the fight for life against stronger organisms which they encounter in the pool. The common soil and water bacteria find conditions much more to their liking and they are stronger than the pathogenic forms.

As a result of this, the man who is in the pool with you is a more real danger to you than the man who was in the pool yesterday. To make the pool safe, there should be a rapid dilution of infective material and a correspondingly rapid carrying away of the dangerous substances toward the exit pipes. Any type of inlet and outlet that will accomplish this rapid dilution and allow the minimum dead water areas will be satisfactory.

Safety Precautions

But a word of caution is needed in regard to pool safety. Do all you can to make the pool safe. Keep everything as clean as you can. Still you are very likely to hear of ear and eye trouble among the users of the pool. A good deal of this is auto-infection. The bathers are carrying the causative organisms on their own body surfaces, and when the maceration of the skin has reduced its resistance to the invading bacteria, they may enter and cause trouble. Rigid inspection of bathers is helpful, but it will not entirely remove this condition.

The maximum safety from dangers incident to insanitary conditions must be given, but attractiveness, comfort and convenience are important also. Hence consideration should be given to toilets, locker rooms, dressing cabinets and showers. They, and the arrangements for handling the towels and suits need careful planning.

The foregoing paper by Professor Hinman was presented at the recent meeting of the Iowa Engineering Society.

CONTROLLING DISTANT UNITS IN A HIGHWAY CONSTRUCTION ORGANIZATION

By O. L. Kipp, Construction Engineer, Minnesota State Highway Department, 1256 University Ave., St. Paul, Minn.

The increase in highway expenditure during the last two decades demands a corresponding increase in the efficiency of the control exercised over such expenditures. During that period highway expenditures in the United States have increased from a total of 59,527,000 in 1904 to a total of approximately $800,000,000 in 1923. The annual expenditures for highway construction have thus grown to an average of over $16,000,000 for each of the 48 states, and there are few states in which the annual expenditure for highway improvement is not at least $5,000,000.

A Vital Question to Contractors

When consideration is given to the immense amount of construction work which is being performed under the direction of the State Highway Departments, the question may naturally arise as to the control which is exercised over the various construction units throughout the State. This is a very vital question to the contractors bidding on work in the State, for, if control is not exercised adequately by the State Department, the cost of the completed work may depend in a large degree on the individual engineer in immediate charge of the work and upon the attitude of the county board awarding the contract. An additional hazard has therefore been introduced by such lack of control, which the contractor must take into account and which naturally results in higher unit prices, unless the contractor is familiar with the treatment to be expected from the engineer placed in charge of the project. Under such circumstances the bidding is not truly competitive. If it is not known what engineer is to be assigned to the work then all contractors must take a chance on the treatment to be received at the hands of the engineer during the progress of the work.

It is imperative, therefore, that the con-

trol of engineering units supervising state highway construction be such that uniform treatment is accorded the contractors throughout the State.

Two Systems of Control of Construction

In a general way there are in the United States two systems of State Highway Department control over construction work: First, State supervision over contracts let by counties; second, Construction contracted and supervised directly by the State Department.

State Supervision of County Work

In the early history of most of the Highway Departments, construction was performed under the first system. This system may be regarded as the first step toward the coordination and control by the State of highway work. While its advantages over individual unrelated effort by the several counties of the State are many, yet control of the construction throughout the State under this system is limited by the attitude of the county boards who award the contracts and make final settlement with the contractor. Under this system it has been the practice also for the engineer in charge of the work to be employed by the contracting county and the control of the contract is therefore further limited by the ability and attitude of the county highway engineer, who supervises the construction. Uniform procedure as to location, design and supervision of construction, or uniform treatment of contractors cannot be fully obtained under this system. In spite of standard specifications and requirements as to plans, in spite of uniform laws, rules and regulations, the characteristics of the boards awarding the contracts and of the engineer under their employ are reflected in the completed construction, the treatment of the contractor and the cost of the work.

Details of Control of County Work

Under this system control by the State Department consists usually in requiring the use of approved plans and specifications, the observance of rules and regulations as to procedure and the accomplishment of construction of sufficiently high quality to justify payment of State Aid. The exercise of this supervision by the State Department is mainly through District or Division Engineers of the Department who have personal contact with the various county boards and highway engineers. This supervision raises the average quality of the county construction, but all too frequently high class work in one county will be found to end abruptly at the county line, where the adjoining county has been unable or unwilling to provide equally satisfactory and progressive work.

Country Control Is Variable

There may also exist a corresponding inequality in the treatment of the contractor on the work. One county board may be very exacting and technical in their requirements, while the board of another county may be more liberal. As long as the county boards do not go to an extreme the State Department ordinarily considers that no immediate or direct action is justified. Those who have worked with county boards will realize that this condition may easily exist even though it is the constant endeavor of the State Department to secure the greatest possible uniformity of action by the counties.

There is a decided improvement in the results obtained under the system where the engineers supervising the work for the counties are employed directly by the State Department. When such engineers are in the employ of the State they seem to grasp the point of view of the State Department more readily and more completely. They are thus able to bring the action and attitude of the county boards into more uniform alignment with the policy of the State Department.

Direct State Department Work

With the growth of highway construction by the States there has been a tendency towards the substitution, at least for the primary or trunk highways of the State, of the second system of control, namely construction contracted and supervised directly by the State Department. In order that the greatest possible degree of success may be obtained under this system, the organization for the control of the construction must be carefully developed along business lines. Responsibility and authority must be placed in one head and a direct line of responsibility must be carried from the head through the whole organization.

Outline of Highway Construction Organization

The following is an outline of a Highway Construction Organization and its operation with particular reference to lines of control over the various construction units:

Acting under the Commissioner of

Highways and the Chief Engineer of the Department the Construction Engineer in accordance with the principle above stated, controls all activities relating to construction. Contact between the Construction Engineer and the work throughout the State is secured by dividing the State into districts or divisions, to each of which is assigned a district or division engineer. These men are in responsible charge of all the highway work in their division, including maintenance and any other interests of the State Department, as well as the various features of construction from the location survey to the payment of the contractor's final estimate. By their personal and written reports the Central office is kept in touch with and enabled to direct all matters of major importance.

Detailed Direction

In order to obtain the greatest possible uniformity the detailed direction of each of the major sub-divisions of construction work is placed under a man especially adapted to handle that work. These activities are grouped under the subheads of surveys, plans, right-of-way, records and accounting, testing and inspection.

Surveys

A high grade locating engineer directs all the locating parties, thereby avoiding to the greatest possible extent lack of uniformity in location. Where the detail of this important phase of the work is left to several men operating under the several division engineers, similar uniformity is impossible. The engineer of surveys works with each division engineer in whose territory the survey to be made is located, and they jointly select the controlling points of the line. The various features of the routes considered are discussed with the Construction Engineer and surveys are made of the lines selected. During the progress of the survey the engineer of surveys gives each locating party such supervision as may be necessary to secure the most satisfactory final location. Information as to the progress being made by each of the parties and the location of the lines being run is transmitted each week to the Construction Engineer on letter-size township plats. These reports, before being placed in the files, are circulated among the various engineers of the Central Office, whose duties require that they keep in touch with this phase of the work.

Each party includes a field draftsman, who keeps the profile and alignment of the lines plotted so that they are available for study and checking during the progress of the survey. On the completion of the survey these plats and profiles are sent into the Central Office with the field notes, where they are checked over by the Chief Engineer and the Construction Engineer, who determine upon the line to be planned.

Plans

All plans are prepared in the Central Office under detailed direction of the Engineer of Plans. The draftsmen, computors and engineers engaged in this work are grouped into squads of 5 or 6 men working under a squad leader. The number of squads may be increased or decreased according to the volume of the work. Before the plans are inked the Division Engineer and the Construction Engineer check the layout and where there is any question as to culverts or other features the working profile is checked in the field by the Division Engineer, or the Engineer of Surveys. The completed plans in each instance under this system of control represent the coordinated policy of the Department, both as to location and design and no section of the State suffers on account of inefficiency or backwardness of a small or distant unit of the organization.

Selection of Projects for Construction

It is frequently good policy to survey and plan work considerably in advance of a definite provision for financing the construction. Highway Departments face the necessity of selecting the projects to be placed under contract from a large group of projects whose early construction is demanded not only by road and traffic conditions, but also by actively interested and influential citizens. Under such circumstances a budget system of control of expenditures is vitally necessary. With a statement at hand showing the probable income of the year, the operating expense of the Department, and obligations on work already authorized, the head of the Department can make an intelligent selection of the projects to be constructed.

Office Engineer

Upon the award of contracts the construction engineer arranges for supervision of the construction. This is handled in cooperation with the division engineer through the office engineer, who has charge of the following work:

1. Cost accounting on all operations of construction.

2. Reports and records of office and field operations.

3. Personnel records of all construction employees.

4. Preparation of all vouchers and reports for the Bureau of Public Roads.

5. Obtaining necessary reports from resident engineers.

6. Preparation for payment of all bills, payrolls, expense accounts and contractor's estimates.

Resident Engineer

There is assigned to each project a resident engineer who has direct charge of the project and who reports to the Construction Engineer through the Office Engineer. The resident engineer's party is composed of an instrument man, rodman and such other assistants and inspectors as may be necessary adequately to stake, supervise and inspect the construction. Necessary instruments, transportation, plans, contracts, specifications and office supplies are furnished. In addition to verbal directions he is furnished a Manual of Instructions which contains detailed information as to methods of procedure, forms, reports and other data, which experience has shown desirable to bring to his attention. Paragraphs such as the following are included in this Manual, so that he may know the general attitude desired by the Department:

Manual of Instructions

"The success of the work throughout the State depends largely upon the courteous, business-like manner in which our engineers handle their dealings with the contractor and the public. The desire of the Department is to promote a feeling of good fellowship between the local officials and the representatives of this Department.

"Resident Engineers, in their dealings with the contractor and public, are expected to follow a courteous, business-like, ethical course and see that justice and fair dealing is given to the contractor as well as the State, and that the work is performed in strict accord with the specifications.

"Resident Engineers, inspectors, rodmen or any employee must remember that all statements given to the public, are taken as a reflection of the attitude of the Central Office and not as a personal opinion concerning the work in question. Every employee is hired to do a certain portion of the work in a thorough, quiet, unportentous manner and not to act as press agent for himself or the Department."

The resident engineer gives the contractor all necessary lines and grades. This includes center lines for clearing, line and grade for all structures, slope stakes for excavation or embankment and grade stakes. On grading operations as the roadbed is brought approximately to grade and ahead of the forms on paving, blue top finishing stakes are set at 50 ft. intervals, or more frequently if required. In grading work immediately before the construction and upon completion, cross sections are taken upon which the exact excavation quantities are determined as the pay quantities for the work.

Reports from Resident Engineer

It is found important in keeping a check on construction that the resident engineer make the following reports:

1. A complete weekly diary containing a statement of the operations of each contractor, operations of the field party and other points of interest is submitted to the Central Office at the end of each week. A photographic record of progress is very valuable, especially where there may be questions as to classification or other details of construction.

2. Weekly force and equipment reports for each contractor. On the completion of any piece of work this report gives the Central Office the total number of man-days for all classes of labor and the total number of equipment days for all types and classes of equipment used by the contractor.

3. Weekly progress reports, for grading, gravel surfacing and paving construction. From these reports photographs are made of the progress of each job from which blue prints are prepared in book form and furnished to those affected, such as the Commissioner of Highways, Chief Engineer, Construction Engineer and the Division Engineer.

4. Where work is encountered that is not covered by unit prices of the contractor, unclassified orders are prepared by the resident engineer and submitted to the Division Engineer for his approval. Work performed under these orders is listed daily on forms for that purpose. These are prepared daily and signed daily by the resident engineer and the contractor, or his authorized agent.

5. Monthly estimates of quantities performed by each contractor, are submitted to the Central Office at the end of each month. From the estimates of quantities of work performed pay estimates are made up in the Central Office, copies of which are furnished to the contractor and to the Resident Engineer.

6. Final estimates are accompanied by final cross sections, plotted on cross section paper, final progress profile platted on profile cloth on a scale of 400 ft., to the inch, field book notes on all records affecting the work. All pay quantities are checked in the Central Office before final payment is made.

In adidtion to all the data supplied with these reports, the Division Engineer maintains close contact with the resident engineer, giving such directions as may be necessary to secure uniform quality of work and uniform treatment of contractors.

Engineer of Tests

Another important line of control on structures and paving projects is maintained through the engineer of tests. All materials entering into such construction are tested at the source wherever practical, and only materials meeting requirements of the specifications are accepted for the work. Constant inspection is also provided to make certain that the details of the plans and specifications are followed. The inspector's work under the resident engineer and detailed information with reference to inspection and tests are given to the inspector through the resident engineer. In order that there may be more intimate contact between those in responsible charge of the work throughout the State and the several phases of construction work, monthly meetings are held at the Central Office. These meetings serve to preserve the unity of the Department and enable the division engineers and other engineers representing the Department to follow a uniform policy in their dealings with the public and their control over the work under construction . Any new designs to be adopted or changes to be made in the specifications are discussed at these meetings so that each man knows in advance about the change contemplated and has a part in its adoption.

Conclusion

In conclusion the adequate control of distant units of Highway Construction requires:

1. That the work be contracted and supervised directly by the State Highway Department.

2. That a direct line of authority and responsibility must be carried from the head of the department through the whole organization.

3. That uniformity in the main subdivisions of the organization be secured by placing those subdivisions under the detail direction of competent engineers.

4. That regular conferences be held with all the engineers of the staff through which they may be kept in line with the spirit and policy of the Department.

The foregoing paper by Mr. Kipp was presented at the recent annual meeting of the American Road Builders' Association.

PURPOSE AND PROGRESS OF CONSTRUCTION EQUIPMENT STANDARDIZATION

By Clarence E. Bement, Vice President and General Manager, Novo Engine Co., Lansing, Mich.

At a meeting of the officers and directors of the Associated General Contractors of America, held in Detroit in November, 1922, there were called in a dozen or more manufacturers of contractors' machinery with a view to the discussion of matters of mutual interest and a bringing about of a better understanding of the problems with which the contractors and manufacturers were confronted. After an afternonon spent in discussion, two points were brought out prominently. First, there has been a lack of any attempt at standardization on the part of the manufacturers of certain classes of machinery where standardization is easily attainable. Secondly, in the matter of getting repair parts there has been a lack of uniformity in the method of ordering, especially from points remote from the main office, where repair lists are not always kept. There has been delay arising from questions of credit and manufacturers have been lax in publishing repair lists with clearly defined cuts and a definite nomenclature common to this particular class of machinery and, most important of all, in filling repair orders with the least possible delay. It was finally decided to appoint a Joint Committee on Construction Equipment, composed of seven representatives of the manufacturers and

seven of the contractors, a representative of the American Society of Mechanical Engineers and, later on, a representative of the American Concrete Institute. These, with R. C. Marshall, Jr., General Manager of the Associated General Contractors, and W. P. Christie, Secretary of the same organization, made up the formal body. However, as much as possible the meetings of the committee have been informal and all those with a vital interest in the problems presented to it have been called in.

Concrete Mixers

The first meeting of the Joint Committee was held in Chicago in January, 1923, the result of the discussion there being, that in the following May a subcommittee of the Joint Committee met with a committee of five concrete mixer manufacturers and a tentative program was laid out for a meeting of the Joint Committee to be held in Chicago June 27th to 29th to discuss the standardization of concrete mixers. This meeting lasted for three days and was attended, in addition to the Joint Committee, by representatives of the larger mixer manufacturers, and representatives of the Western Society of Engineers, American Society of Civil Engineers and the U. S. Bureau of Public Roads, the American Society of Mechanical Engineers being represented on the Joint Committee. It developed early in the discussion that the non-tilting and paving mixers formed a class so radically different from the tilting type that it was decided to hold a separate meeting the third week in July to take up the standardization of the latter class.

Fundamentals Agreed On

The discussion was carried on under some thirteen heads covering most of the points capable of standardization. There was a spirit of "give and take" shown on the part of the manufacturers that boded well for the success of the movement. It is true no radical steps were taken and no vital changes made in the present product, but certain fundamentals were agreed to that, if properly followed up, will go far toward simplifying and standardizing this class of machinery.

Standards of measurements were adopted, being the cubic foot and the U. S. standard gallon. The rating of boilers is to be the A. S. M. E. h.p. rating; steam and gas engine rating is to be referred to the same authority, and the rating of motors to the American Institute of Electrical Engineers. The mixer rating and drum capacity were not agreed to, although it was the consensus that the water capacity of the drum when stationary was the rating basis, the maximum operating grade to be used in the rating of pavers being 8 per cent. A standard table of mixed aggregates was adopted.

Paving and Building Mixers

Perhaps the most important action taken was the adoption of standard sizes for paving and building mixers. The paving mixers are to be of three sizes: 7-E, 12 or 13-E (to be decided by referendum of the Associated General Contractors) and 21-E. Six sizes of building mixers are to be standard rig: 3½-S, 5-S, 7-S, 14-S, 21-S and 28-S. The A. S. M. E. standards for shafts, keys, keyways and gears were recommended though not adopted. A standard nomenclature was recommended, that of the Concrete Mixer Association being used as the basis. A standard name plate was adopted, permission to use it being granted to the manufacturers on their conforming to the standard requirements of the A. G. C. The tilting mixer manufacturers met on July 30th and adopted practically the same standards as the non-tilting mixer manufacturers, modified to their particular type of mixers. The recommendation of the manufacturers as to sizes of the tilting mixer was that two sizes under the 7-S size be made standard, namely, 5 cu. ft. and 3½ cu. ft.

Wheelbarrow Standardization

In connection with the discussion of standardization of concrete mixers, the subject of wheelbarrow standardization was taken up, and a report made on this subject by Mr. H. H. Baker. Under this report, which was accepted by the committee, wheelbarrows are divided into four classes as regards their trays, with capacities running from 2 cu. ft. to 3½ cu. ft. There seems to be a fairly unanimous agreement on the part of the wheelbarrow manufacturers as to the classification in regard to capacity of trays and the gauge of the material that shall enter into the different sizes. In this same report, three types of handles were suggested, covering those made by most, if not all, of the wheelbarrow manufacturers. A standard leg is also shown, which, however, is subject to the variation of the various manufacturers. The result of the wheelbarrow classification will be to cut down the sizes, keeping them as nearly

as possible to the number adopted during the war, at which time a good many sizes were eliminated to the profit of all concerned.

The same condition will apply to wheelbarrow standardization as to standardization of concrete mixers, namely, that this standardization will not produce interchangeability, even in the matter of trays, as, although the capacity may be the same, the form will ordinarily vary among different manufacturers; the real accomplishment will be the reducing of sizes, the agreement on capacity and gauge of tray and general uniformity in construction, as regards wheelbarrows manufactured for different classes of work. While further standardization may take place in the development of this work, there is the natural desire of the manufacturer to maintain his individuality and cultivate talking points in which he feels he is superior to his competitor.

The Significant Developments

As will be evident the really vital accomplishment of this first investigation of the Joint Committee on Construction Equipment, is the agreement on sizes and the adoption of standards of measurement of capacity. Standardization in the case of concrete mixers and wheelbarrows, will not mean interchangeability of parts between different manufacturers; such a result is not attainable, and may not be desirable, but certain standards have been and will be set up that will force the manufacturer to build his machine up to an agreed standard of capacity and efficiency, and bring standardization in those parts and operations which are common to all mechanical equipment.

The interchange of ideas brought about by the discussion of the disputed questions, is one of the by-products of this investigation, which will clarify the mechanical atmosphere and eliminate a certain amount of mistaken mechanical ideas, all in the interest of simplification and standardization. We must recognize the fact that the manufacturer in his natural and proper selfishness is not going to give up any of the things that are peculiar to his own product and which he believes makes it superior to his competitor's. Neither is he going to make it easy to duplicate his machine or the repairs that are naturally called for. In the standardization of automobile parts it has been found impossible to carry this work beyond the point at which the proper selfishness of the individual manufacturer was affected by making his product so uniform that parts could easily be duplicated by others than himself.

The story that comes out of Germany, that in the manufacture of locomotives different manufacturers have been able to divide up large orders between the various institutions and provide parts that were absolute duplicates, is not a program that will appeal to the average American manufacturer. Simplification of parts, elimination of unnecessary sizes by agreement between the different parties involved, adoption of standards of measurements that are common to all, adoption of standards set up by the various societies as regard the quality of material, standards of threads, gears, etc., these are the things that can be brought about with a fair degree of unity, and with a reasonable amount of cooperation, and will furnish the foundation for carrying on this work.

It must be remembered that no undertaking of this kind can make an impressive showing within a short time, but it is a matter of continuing pressure and the maintenance of an organization that will keep everlastingly at it.

The foregoing paper by Mr. Bement was presented at the recent annual meeting of the American Road Builders' Association.

THE DESIGN OF RELIEF SEWERS

By A. W. Consoer, of Consoer, Older & Quinlan, Consulting Engineers, Marquette Bldg., Chicago, Ill.

When we come to consider "relief sewers," we approach a subject and a type of construction that promotes itself. Flooded basements and ponded streets create a demand for relief that no conscientious city council can ignore. During the year 1923 there was a brisk demand for relief sewers because of several rainstorms of long duration and unusual intensity. Records of the U. S. Weather Bureau for 1923 show that the year witnessed weather conditions that provided a real test for storm water sewer systems and combined sewer systems in Illinois.

A Rainy Season

Rainfall statistics are never entertaining, but it is interesting to note that in Chicago on Aug. 11, 1923, there was a rainfall of 1.95 ins. between 1 and 2 a. m. This was followed by a drizzling rain

lasting until 7 a. m. Then between 8 and 9 p. m. there was precipitation of 0.47 ins., and from 9 to 10 p. m., 0.55 ins., with a total for the day of 3.70 ins. This was the greatest rainfall of the month of August since 1871 and is the largest daily precipitation since 1871 on record in the Chicago Weather Office with the following exceptions: August, 1885, 6.19 ins; July, 1878, 4.14 ins. The records for these last two days, however, show lower hourly rates. Similar rainfall statistics for 1923 are available for Sparta, Paris and Freeport, showing that rainstorms of long duration and unusual intensity were experienced quite generally throughout the State of Illinois during August, 1923.

These conditions overtaxed many existing sewer systems, flooding basements and ponding the streets, alleys and in some places the sidewalks and lawn spaces. As a result, many property owners and municipal officials demanded relief sewers.

The design of a system of relief sewers is usually a more definite problem than the design of a new system.

Abuses of Sanitary Systems

Sanitary systems are usually overdesigned and give little trouble except where they are improperly used; namely, by permitting roof water connections or connections for street inlets. For such conditions the sanitary sewers are easily relieved by removing the improper connections. It is worthy of mention that in the writer's practice it is the exception rather than the rule to find a sanitary system being properly used, particularly in the case of systems constructed several years ago. It is frequently found that in order to cheapen pavement construction, inlets are connected to sanitary sewers. City officials frequently do not realize that their "sewer system" is not intended to carry storm water. Very few towns are found where rigid control is exercised over roof connections to the sewers. As a result, some sanitary systems were overtaxed by the August storms and created a demand for remedial measures. The remedy in such cases is simple: The construction of storm water drains which will intercept such improper connections to the sanitary sewers.

Combined Sewers Growing in Favor

For a number of years just past, sentiment among sanitary engineers has been in favor of the double system of sewers, just as practice, when sewers were first built, favored the combined system of sewers. Abuse of sanitary systems and more rational methods of storm water sewer design have in the past few years found engineering practice again favoring combined sewer designs. In the writer's practice, very few instances have been found where a double system is cheaper in first cost, particularly if allowance is made in the estimate for the additional cost of double house connection sewers. In such estimates, allowance must be made for higher cost of sewage treatment in case of the combined system.

Relieving Combined Sewers

In the case of combined sewers requiring relief, the problem of design is more complex than in the case of overloaded sanitary sewers. There is one advantage the designer has in the matter of relief sewers which he does not ordinarily have in designing a new system. Relief sewers are usually demanded for built-up areas, so that the survey can determine quite accurately the percentage of impervious areas in the various tracts under consideration. The survey should also be a complete inventory of existing sewer facilities with notes on condition of existing sewers, location and size of storm water inlets and connecting pipe. Data on basement elevations and high water conditions at the outlet are often of extreme importance. Sometimes it is desirable, particularly on trunk lines, to make gaugings to determine the value of "n" in Kutter's formula, as this is a most important factor in determining the actual capacity of the trunk sewer.

The Survey

The making of such a survey and investigation is a laborious task and is far more expensive than what is ordinarily necessary in a survey for a new system. But if property owners are to be assessed for relief the engineer must be very sure of the sufficiency of the relief sewers he designs.

Rainfall Data

The most difficult problem in the design of relief sewers is to analyze properly the rainfall data for the locality in which relief sewers are to be built. Although the government weather bureaus and other agencies have greatly increased the volume and accuracy of rainfall data, we still have only meager information

regarding the extent and distribution of rainfall during heavy storms, and when we come to the matter of length of time required for storm water to reach inlets, there is practically no information in the literature of the subject. Recently some interesting experiments have been made and explained by Frank A. Marston, member of the American Society of Civil Engineers. These experiments indicate that for the ordinary sewer district a uniform rate of rainfall throughout the district during extreme storms must be provided for in the design of relief sewers. The paper describing these experiments is published in the Proceedings of the American Society of Civil Engineers for January, 1924.

Correcting Outlet Conditions

In the writer's practice it has been found that remedying conditions at the outlet of the sewers will frequently effect considerable relief to a sewer system at a small expense. Recently, investigation was made of a combined system where pumps were installed at the outlet to lift the effluent of the outfall sewer from a collecting pit into the outlet stream. Investigation showed that the capacity of the pumps under the most favorable conditions was only one-fourth of the capacity of the outfall sewer. Similarly, the capacity of several outfall sewers has been found to be seriously impaired by high water conditions at the outlet. This condition can be remedied frequently by the installation of suitable pumping equipment.

Changing Hydraulic Grade Line

A study of existing basement elevations will frequently permit the use of a more favorable hydraulic grade line for old sewers in connection with a relief system than would be used on new design, so that data on basement elevations is needed in the design of relief sewers. In one instance a study of basement elevations made it desirable to count on an existing sewer laid on a flat grade to discharge at both termini.

In general, the design of relief sewers calls for most careful examination of existing sewers, topography, character of occupation, character of soil, distribution of sidewalk, pavement, and roof areas, rainfall data, high water conditions at outlets, and other features involved in the design. A problem in the design of relief sewers usually provides many opportunities for the exercise of engineering ingenuity, and calls for the expenditure of considerable time and effort on the part of the engineer, because in designing relief sewers he is usually dealing with localities where property values are high, and damage from imperfect sewerage is costly and the source of much inconvenience and annoyance. It is a class of engineering work which should be done with painstaking thoroughness and is certainly no field for hasty, rule-of-thumb methods of design.

The foregoing paper by Mr. Consoer was presented at the recent annual meeting of the Illinois Society of Engineers.

HIGHWAY IMPROVEMENT A CONTINUING BUSINESS

By Thomas H. MacDonald, Chief Bureau of Public Roads, Washington, D. C.

No proof is needed that any business, large or small, does not carry on unless securely founded. Its possible lifetime and potential growth are measured accurately by its service. And this term is used in its broadest sense, embracing all the factors of demand, extent, cost quality, time, availability and substitutes. These and many other factors have an important bearing.

Can conclusions be drawn from existing conditions upon which to predict the future? I think so.

You may or may not agree with the conclusions but there can hardly be a disagreement as to the facts. It must be remembered, however, there may be and doubtless will be wide local variations from any general tendency which do not affect materially the results in the aggregate or on a national scale.

Highway Transport

Highway transport is now nation-wide and its service is daily extending. One of the outstanding principles developed in the transportation study made by the U. S. Chamber of Commerce is the utility of motor transport in the broad general scheme of transportation. What a remarkable change and crystallization of expert transportation opinion was evidenced in the resolutions of the Transportation Conference called to consider the reports of the several committees of the Chamber which have been working for the past eight months. I quote briefly—

"The motor vehicle has proved its unquestionable value in our economic system ****."

"The congestion of transportation today centers around the terminal areas of our great cities *****."

"Store door delivery by motor truck is the greatest contribution which can be made to the solution of the terminal problem ******."

"Organized motor transport can also relieve the railroads of various forms of uneconomical service ***."

"Outside of the terminal areas it is to the public interest as well as to the interest of the respective carriers, that the economic limitations of each type of carrier be recognized *****."

The above statements are not the full text but an indication of the very definite place assigned motor transport.

Highway Service

Inclusive of city streets, it must be plainly evident that the service of the highway is rapidly being extended to almost every individual. Future developments in transportation will assure general services of a valuable character quite apart from the direct services to the road user.

Motor Vehicle Registration

The present registration of motor vehicles is about 13,500,000 and the Bureau now estimates a total registration for 1924 of approximately 15,000,000.

Highway Program

Do not these facts indicate what a tremendous experiment in transportation the American people have undertaken? Consider in all seriousness the accumulative costs of utilizing this rolling stock without adequate highways. There is no longer a question as to the earning capacity of improved highways in saving operating costs and in rendering valuable services but highway transport is not self contained as is rail transportation. The major difference between the two introduces some difficult questions of equitable financing.

An outstanding feature of the road program of the past year has been the publication of the map of the Federal Aid Highway System. Its greatest importance is in the unanswerable fact that the 48 States and the Federal Government have defined a major objective and are not working on this gigantic task of road improvement in a blind or haphazard way. Individual States have been working for years on a systematic program. The building of such a map was possible because of the progress they had already made in the selective processes. Many had never received recognition or credit for their efforts from self-constituted reformers and propagandists. Now we have a national scheme with all the authority of both the State and Federal Governments upholding it.

That this broad definite plan has been completed and adopted will inspire greater confidence in State Legislatures, and in Congress. It will also be subject to attack because of its relatively limited mileage. Examine this plan. It appears comprehensive and so it is. The roads included are all major in importance in each locality and the network connects practically all county seats, but admittedly there are many miles of importance not included. These must come later. If this country is to succeed with highway transport it must rigidly adhere to systematic planning and building of its highways in the order of their importance.

This is a big country, and roads are intimate affairs, that is, they must be available near at hand. So there is a tremendous mileage. If the whole population of the country were spread out on the legally constituted rural highways, there would only be about 30 persons per mile.

We may divide this big mileage into two general groups:

Group 1. This is composed of the State systems and is largely under State jurisdiction, 220,000 miles.

Group 2. This includes all other roads and is largely under county, township, town or district jurisdiction, 2,640,000 miles.

This figure, however, is very misleading. A very large percentage of this mileage, while legally dedicated for public highway purposes, has never received any expenditure, is used by little and perhaps no traffic, and will not for an indefinite period, if ever, justify any improvements as a highway.

The total of the two groups is 2,865,000 miles. Consider the chaotic conditions that must exist unless order and system rules.

It is estimated that about 387,000 miles total have been improved to some extent or 13.2 per cent. This is the net accumulation in over a century and this is 93 per cent of the cheaper types. The total paved mileage is placed at about 26,000 miles, 1922 figures.

The Federal Aid Highway System of 170,000 miles as now approved is included in Group 1 and is coincident with about 80 per cent of it. The Bureau estimates there are now about 110,000 miles yet to be improved with roadway surfaces adequate and suited to the traffic needs. If this system is completed in the next ten-year period, there must be an annual program of 11,000 miles of new construction. This is somewhat larger than the mileage of Federal aid roads that has been completed in any one year including the graded only, which are built as stage construction and are yet to be surfaced.

At the present time there are under construction approximately 15,000 miles of Federal aided roads, estimated total cost $290,000,000. The Federal aid funds appropriated or authorized are sufficient to continue an average program equal to this amount for approximately two years. At this time there is, in general, no reason to doubt the ability of the States more than to meet the Federal funds to carry on this program. There are some individual States where a greater proportion of the cost of certain roads ought to be borne from Federal funds. In addition to the Federal aid program there will be a continuance of the highway program in the following distinct phases:

In Addition to Federal Aid Program

1. State and State-aid construction in addition to the Federal program. The combined State and Federal cost of Federal aided projects will probably not be greater than 70 per cent, judging from the past two years, of the total cost of construction carried on under the State jurisdiction.

2. The program of construction designed to take care of specific intense traffic problems must be increased. The supplementary use of trucks within the terminal areas to relieve congestion and speed up transportation will increase rapidly. This will transfer a certain part of the highway program into the terminal areas and to new terminal areas, and the amount of new roadway construction to take care of this phase of transportation is likely to increase greatly in the near future.

There is also in connection with population centers certain acute problems which will require large expenditures such as the building of roadways to connect with, and distribute traffic from, the new vehicular tunnel between New Jersey and New York, and the rebuilding and widening of the Boston Post Road east of New York.

We have reached the time where arterial roads must be built connecting business and residential areas and through routes to detour heavy traffic around business and residential districts.

Thus, a large amount of new construction must come at once around the big population centers to take care of the traffic problems which have arisen and it is my judgment that the expenditures for these purposes will largely increase in the near future.

3. For the past three years the total estimates of the Bureau show that the road program has reached practically the billion-dollar mark, including payments on bonds. Of this expenditure, about 40 per cent has been expended under the supervision of the state highway departments, and used for the roads in Group 1 as outlined above. About 60 per cent has been expended by local authorities and expended on the roads of Group 2 above. It is my judgment that the local expenditures will be materially decreased, partially because of the completion of important local roads, and partially because of opposition to land taxes, particularly on the part of the farmer. This change, however, would be only in line with the general tendency which has been very evident in recent years to concentrate more and more the expenditures under the state highway departments and at the same time to increase the jurisdiction of these departments over larger mileages. This tendency is well shown in the accompanying table, showing estimated approximate expenditures since 1904.

RURAL HIGHWAY EXPENDITURES

STATE

Year	Construction	Maintenance	Total
1904			$ 2,549,912
1914			24,220,850
1921	$291,973,813	$ 74,526,746	*413,241,662
1922	286,600,000	73,500,000	†429,896,572

*Includes $46,741,103 for administration, engineering and miscellaneous.

†Does not include payment for principal and interest on bonds.

LOCAL

Year	Construction	Maintenance	Total
1904			$ 56,977,258
1914			216,042,934
1921	$334,991,560	$174,066,423	**623,346,110
1922	330,000,000	171,500,000	468,455,735

**Includes $114,286,127 for administration, engineering and miscellaneous.

GRAND TOTAL FOR STATE AND LOCAL

Year	Grand Total
1904	$ 59,527,170
1914	240,263,784
1921	***1,036,587,772
1922	†898,352,307

***Includes $161,027,230 for administration, engineering and miscellaneous; if miscellaneous payments are deducted to get a figure comparable with 1922 and 1923, we get $911,589,895.

†Does not include payment for principal and interest on bonds.

ESTIMATED STATE AND LOCAL FOR 1923 †$943,139,148

†Does not include payment for principal and interest on bonds.

The foregoing matter is from an address by Mr. MacDonald at the recent annual convention of the American Road Builders' Association.

THE ENGINEER AS AN EXPERT WITNESS

By Charles H. Young, President, Central States Engineering Co., Muscatine, Ia.

The services of an engineer as an expert witness are valuable where a determination of facts depends upon engineering knowledge. The method used in securing facts should follow some logical order and have a well defined analysis of the particular questions involved. In rendering this service, the engineer should look ever to the viewpoint of rendering justice and maintaining the high standing of his profession.

Attorney Hoose of Bloomington, Illinois, in summing up the engineering profession and its value to the courts made the following statement:

Value of Engineering to the Courts

"There is an unusualness about your profession that is characteristic of few others. Yours is always a work of a constructive nature. There should be a great satisfaction to you in the knowledge that you are following a life vocation which is curative and constructive in its nature. Each endeavor of yours is calculated to improve and better the conditions of affairs in the community you serve.

"And, too, there are many responsibilities. The problems of millions of people involving, not only their property, but their health and safety as well are directed to you for solution. The destinies of municipalities and communities rest in your hands.

"This confidence of fate has been well reposed. The high-mindedness, the earnest studiousness and eminent fairness of those who have accepted these duties and responsibilities justify the wisdom of the choice and have made engineering one of the learned and honored professions of the world."

The service which an engineer renders as an expert witness, should be divided into the following divisions:

(a) Preparation.

(b) Assisting attorney to ground facts.

(c) Testimony on the stand.

(d) Assisting attorney during trial.

Preparation

As the duties of the engineer are those of fact finding, he should confine himself to the particular case involved. It he is assisting in compiling the allegations, these should cover the basic points to be fought out in the trial.

If the engineer is preparing the facts to combat the allegations, he must know what the allegations are before he can be qualified to present the proper facts to combat them.

It has been my experience that too often an attorney does not consult a reputable engineer when compiling the allegations, but uses a dragnet of supreme court decisions, expecting to catch the proper point by reason of these allegations. And, very often the engineer is merely called to the stand to substantiate some engineering facts, when an engineer has had no knowledge of what the allegations are and is often unqualified by reason of his experience in his particular line to give any more than hearsay testimony.

Rather, before any controversy is started involving engineering knowledge, the best attorneys are in the habit of engaging the services of a reputable engineer to assist them in the preparation of the allegations and the preparation of facts to substantiate the allegations.

In nearly all of the cases, with which I am familiar, where the allegations have already been filed and it is desired to combat the allegations, the services of a reputable engineer have been engaged to prepare proper report and complete analysis to combat the points which the opposing side are attempting to prove. This affords a secure foundation upon which to build the superstructure of the case and opens a field where the engineer has ample opportunity to exercise his ingenuity.

Assisting Attorney

In general, however, the reports consist of a title page stating whether or not it is the intention to substantiate or combat the allegations, the title of the case, the person making the report and the date. The introduction sets out the objective and the order of presenting the information, which is followed by a typewritten list of the allegations, which are numbered.

Each allegation is next analyzed and abstracted and those of like purpose eliminated. Then follows a presentation of facts either to combat or substantiate the allegations, which are referred to by number.

In the furnishing of facts, a detailed explanation is inserted showing just why and how the facts were secured, from whom and where the engineer received the information, and other data which might be pertinent in building a foundation for the case. If a statement of court decisions is necessary, to substantiate or combat the allegations, notes of these cases should be thoroughly ferreted from the court decisions by a study of such cases and should appear in the data furnished. For, to be a successful expert witness, an engineer should be familiar with that phase of the law which pertains to the particular case involved and it is an advantage to the attorney if an engineering witness knows something of the law, as well as engineering, because of the connection of the engineering facts in the particular case involved with the legal requirements.

This enables the engineer to prepare the proper facts and often to pick out procedure which should be used in the case. If an engineer does not know what he is trying to prove or the supreme court decision which might modify his judgment, in selecting facts, then he is blindly securing information. Someone has, truly, said, "that the world gets out of the way of the man who knows where he is going."

This being the case, an engineer should have enough knowledge of law to enable him to know how to look up cases and recognize their importance, if he desires to be a successful expert witness. And, the attorney with whom he works will greatly appreciate this fact, for he knows that a case is frequently won by reason of the proper preparation of the factors.

Following the printed analogy an appendix should be inserted, which should contain plats, profiles, tables, graphs and other information pertinent to the particular case involved. This appendix should be clearly explained in the report by reference thereto. I have found that the coloring of plats in order to improve the conception by the court or jury as the case may be and to which proper reference can be made, has proven invaluable, in clarifying the facts in court, thus making them readily understood by the non-technical observer. Likewise, the simplifying of engineering terms into language which can be clearly understood by the court is an advantage and can be cultivated by experience of the witness. As an example, I am familiar with a case where the engineering witness proceeded to insert hydraulic formulas into the record without an explanation of what the factors in these formulas represented. The judge objected on the ground that the testimony was not clear to him or the jury. Thus, the ability to simplify should be cultivated.

On the Witness Stand

In placing himself upon the witness stand the engineer should take his oath as required and register with the Clerk of the Court in order that his presence in court might be recorded and his fees listed. As the fees allowed by the state law would be vastly insufficient to encourage any engineer to fit himself to be an expert witness prior arrangement should necessarily be made with his client concerning compensation beyond that allowed by the court.

Too often, engineers forget the item of overhead in their business, and the absences from their office for duties in court quite often come at a time when supervision over business details is necessary on some project in progress. In a court case, the witness obligates himself to be on hand at the time that the case is called. And, all other business obligations must be set aside and the day in court respected. Therefore, engineers cannot afford to work for the same fee in court as on regular work; the duties in court are exacting and require special knowledge on the particular question involved. The service rendered is often an occasional service during the year.

We read a great deal today about the engineer selling himself to his clients; but, in court, some of the first questions asked are "Who are you? What has been

your experience, with the particular problem involved and like problems? Have you ever been in responsible charge of work of this nature and where?"

"What have you on your shelves, so to speak, to enable the court to know that you are qualified to offer testimony that would be of service in arriving at a just conclusion in this particular case?"

When testifying on the witness stand the control of temper is important; for one cannot think clearly when his temper is aroused. There is no reason for anger on the part of the witness for the attorney is merely attempting to extract the facts in order that a proper knowledge of the questions involved may be had by the court. If the attorney resorts to ridicule, flattery, praise, intimidation, inflection of voice and leading questions, he is merely using these tools of his profession in a just and logical manner. The best attorneys, however, in this day do not resort to these tactics, for they are merely trying to determine whether or not the witness is qualified to give testimony on the particular question involved. And, when an engineer cannot give testimony by reason of his own experience and is merely giving hearsay testimony to the court, his answers do not carry much weight in the decision.

Good attorneys are masters of psychology and can often discover the thoughts of the witness as betrayed by his facial expressions and a witness who is capable of masking his feelings by facial control and expression has acquired an accomplishment which is indeed an asset in his work.

To be able to think quickly and to observe when a hole is being dug on any questions is an accomplishment which requires practice and a knowledge of the methods pursued by attorneys; for an attorney who wishes to win his case should know something of the traits and the extent of the knowledge of the witness before he examines him in order that he may know how to attack his weak points and avoid his strong points.

Good legal practice, today, however, does not include the taking advantage of a witness because reputable attorneys do not desire to have non-meritorious victories to their credit. And an attorney who wishes to keep his practice desires only to win such cases as are meritorious for, although at the time public opinion may be warped, the "truth will out" and react in the future.

Often a witness is subjected to an analysis of his hobbies, his likes and dislikes in order that some joke might divert him from his trend of thought for the time and then a solid question quickly inserted might receive an unexpected answer. Intimidation and inflection of voice are used to find out the character of the witness and have nothing to do with personalities between the attorney and the witness, except as they are used sometimes by some attorneys for "grand stand" plays.

One common method of procedure is to use repeater questions; that is, to ask the witness the same question alternately with some other questions in order that it might be ascertained whether the witness would answer the same question in the same manner and if the attorney observes that the question is not answered in the same manner the second time or the third he can say "I thought you told me a minute ago that such and such was the case." Another method, used by some attorneys, is to ask questions and have them partly answered and then proceed to the next to such an extent that the real questions can be quickly asked and a successful answer obtained.

During the trial and during the cross-examination of technical witnesses on the opposing side a witness can be of great value to his attorney by assisting in compiling the questions to be asked. For this purpose, I use a three by five inch index card and record the answers of the opposing witnesses and then supply propounded questions for the attorney in order to draw out contrary testimony which may be instrumental in establishing the true facts.

The analysis of the subject presented above brings us, then, to the realization that a successful engineering expert witness must support the standards and ethics of the profession.

The foregoing paper by Mr. Young was presented at the recent annual meeting of the Iowa Engineering Society.

RELATION OF THE SUBGRADE TO WEARING SURFACE OF ROADS AND PAVEMENTS

By Will P. Blair, Vice-President, National Paving Brick Manufacturers' Association, Engineers Building, Cleveland, Ohio.

In view of the well established effect of water or moisture in rendering the

subgrades uncertain, variable and lacking as a support to the wearing, artificial surfaces of our roads and pavements, it becomes the task of the engineer to exercise his utmost ingenuity and ability to eliminate the water or moisture from the soil that furnishes the ultimate support to all or any superstructure, including the load, wear and tear of traffic, that may be placed upon it.

The bearing power and supporting strength of the subgrade will be in proportion to its dryness and freedom from moisture and unless the water in the subgrade is reduced to a minimum, the intermittent expansion and contraction due to the presence of water or moisture will impair the wearing surface to a greater or less extent, according to the amount of water present.

Character of Subgrade Soil

The character of the soil composing the subgrade should determine the treatment which will most effectively eliminate the moisture content. The kind of treatment must therefore vary with the character of the soil if economy is to be conserved and efficiency attained. Some soils are close grained and very plastic and difficult to drain when once saturated with water. Other soils contain a greater or less proportion of sand and gravel, are readily drained and are more easily maintained in a dry condition. The range of contraction and expansion is much greater with the close grained soils than those containing sand and gravel, hence the greater damage effect exerted by subgrades composed of such soils, lacking in coarse materials, so that it is all the more important to maintain in a dry state, the soils that are the most difficult of drainage.

On portions of road routes, very often, stretches are found wherein the natural conditions are such that the gravel and sand are intermixed with the soils which together with the surrounding topography, are such that but little artificial treatment is needed to stabilize the subgrade. The natural condition found is largely sufficient.

Design Should Vary as Subgrade Changes

It follows, therefore, that road design over any great distance must vary in accordance with conditions found en route, if we are to construct our roads with no greater expense than is necessary to build the road commensurate with the traffic imposed.

It has been found that a layer of coarse material, gravel, broken stone or slag, placed approximately 2½ ft. below the surface of the pavement, very greatly obstructs the upward flow of water by capillary force, into so much of the subgrade and artificial base of whatever character, and thereby insures a uniform stabilization of the entire structure overlying the layer of such coarse material. This measure of treatment may be thought to involve expense beyond the benefit secured; but the powerful grading and excavating machinery now available for trenching the entire width of the structure and in turn throwing back the earth, covering the layer of broken stone, is really not expensive when the proper implements are used in handling the soil.

The Layer of Coarse Material

After the installation of the layer of coarse material to the width of the wearing surface of the road, it is quite possible to extend the layer of coarse material through the berm to the longitudinal disposal drains at the roadside.

Saving on Maintenance and Reconstruction

The money spent in this character of road construction is clearly compensated for in the avoidance of subsequent expense that follows in maintenance of roads wherein such provisions are ignored. The item of expense in maintenance and repair, which to a very large extent can be avoided, is the cost of filling and leveling up to the surface which sinks away because there is not sufficient support to hold the surface to its original alignment. The upper thrust of the expansion of the subgrade often destroys and breaks up the wearing surface, and works incessantly in the destruction of the artificial base and wearing surface.

Then, too, the acceleration of the expansive force which follows the condition of a subgrade saturated with moisture, subjected to the influence of low temperature, finishes the destruction of the road, regardless of whether it is subject to the traffic use or not.

Any road which is put out of use by law, on the ground that traffic will destroy it, is an economical waste. The law of this character which has for its purpose the preservation of the road becomes operative at a season when their use should be at the peak of service—during the season of the year when work in the fields is at a standstill.

Road Building in a Rut

The rut into which road building has fallen, not only entails great expense in upkeep, but it affects all sorts of activities with grim disaster outside the commercial loss. Schools are closed, church doors are locked and gates are closed against social and neighborly uplift which can not be measured in dollars and cents, all due to the careless and thoughtless way of road improvement.

Ignoring Scientific Methods

But the still greater calamity that we are facing by ignoring scientific methods which beget durability of our roads, is the fact that if ignorant road design is adhered to as evidenced by the experience of costly repair of most roads as now built, we shall be utterly unable to finance the repair of the roads when the mileage of so-called road improvement reaches a figure somewhere near the present popular demand. Then repair will become impossible and the hoped-for roads will become a disappointment instead of a realization.

The foregoing paper by Mr. Blair was presented at the recent annual convention of the Illinois Society of Engineers.

MAKING EQUITABLE RATES FOR ELECTRIC SERVICE

By W. J. Greene and E. A. Holloway, Iowa Railway and Light Co., Cedar Rapids, Iowa.

Electric service is now rendered almost entirely from common transmission systems supplied with electricity from a few central power plants. Formerly each city or town, if electrified at all, was served by a local power plant. There was no community of interest as between cities and towns. The present diversity of rates is due largely to an inheritance from the earlier days of isolated service and to the fact that the power of fixing rates has been vested by law in each council and that rates have been established largely by barter. That law has become archaic.

Towns, which are served from a common transmission system should have the same rates, and all cities connected with this same system, and having populations within certain ranges, should have like rates. Consumers in one city or town who have the same consumption and load characteristics as the consumers in another place of the same class have just cause for complaint when they compare bills and find, to them, an inexplicable difference.

The First Step

The first step toward equitable rates for towns and cities served from a common system is therefore the establishment of uniform rates for all such towns, and for such cities which have populations falling between predetermined amounts. It is pertinent here to make note of the fact that the differential in rates between large Iowa cities and towns is small. The density of population with respect to distribution is the influencing cause for the difference in the costs between such places. In so far as production and transmission costs are concerned all consumers with the same load and consumption should have the same charge regardless of the size of the town or city. The capacity costs of production and all the costs of transmission should be allocated to towns and cities on a basis of demand, and the energy cost of production on a basis of the consumption of electricity. The utility may as a whole be earning a fair return from all the cities and towns but the revenue is not equitably distributed as between like consumers in the different places.

Basing Rates on Cost of Service

The next step toward equitable rates is to find that form of rate expression which will cause each consumer of a class to pay for service in proportion to the cost of the service. By equitable rates between consumers is meant such rates as will cause each consumer to pay for service in proportion to the cost of the service. The writers accept the cost method as the only equitable one upon which to base rates. This paper will, of course, be of little interest to those who hold that rates should be based on the value of the service, or on what the traffic will bear, or on what some other town or city pays.

Separating Costs

All the costs of electric service can be separated into three elemental groups and one general. It may be impossible to obtain the unanimous agreement of Cost Accountants regarding the exact expenses, or parts of certain expenses, that should go to one or the other of the elemental groups, but the statement is made, with confidence, based on considerable experience, that fully 90 per cent of such accountants would agree on the ap-

portionment of fully 90 per cent of the expenses.

Consumer, Capacity and Energy Expense

The expenses after separation into the three elemental groups are generally referred to as the Consumer Expense, Capacity or Demand Expense, and Energy Expense. The general expenses can be disposed of by allocating the entire amount to the three elemental groups by the dollar method, that is, in the proportion that the expense of each group bears to the sum of the expenses of the three groups, or by putting part directly to the consumer element and the balance to the three elements by the dollar method. In this case the part of the general expenses which are charged directly to the consumer element should be excluded when apportioning the balance of the general expenses.

The consumer expenses are those that are a function of the number of consumers and are in no way affected by the number and size of the lights, motors, and heating devices, or by the kilowatt hours used.

The capacity expenses are a function of the number and size of the lights, motors, and heating devices used at one time and are not affected by the hours of use, although as will be shown later they can be made to function partially with the demands and partially with the kilowatt hours used.

The energy expenses are those expenses which vary directly with the kilowatt hours used and are composed only of fuel, boiler room labor, and water for boilers.

Consumer Expenses

The consumer expenses can be introduced in a rate system in a number of ways:

(1) A flat rate per kilowatt hour found by dividing the total consumer expense of a class by the total kilowatt hours used by all the consumers in the class.

(2) A flat rate per kilowatt hour for a predetermined number of kilowatt hours found by dividing the total consumer expenses of a class by the total kilowatt hours of all bills included in the predetermined number, say, the first ten kilowatt hours used each month.

(3) Step rates. The first step found by dividing part of the consumer expenses by the kilowatt hours included in, say, the first 10 kilowatt hours and the second step rate found by dividing the balance of the expenses by the kilowatt hours included in, say, the next 10 to 20 kilowatt hours.

(4) Partially by one of the above methods and partially by the imposition of a minimum bill.

(5) By a monthly charge which includes a specified number of kilowatt hours and covers a portion of the consumer element expenses with the balance of the expenses covered in a predetermined number of kilowatt hours as in the second and third methods.

(6) By a monthly charge which covers all the consumer element expenses.

The methods are arranged in the order of their fairness beginning with the most inequitable and ending with the most equitable. The last method is clearly the only truly equitable method as between consumers, and is as well the most simple. The 5th plan is superior to any of those preceding it but with it those consumers who use less than the average kilowatt hours upon which the rate may be based do not pay for all the costs they create. The inequalities can, however, be made much less than by any of the former methods.

Political Influence

The residence consumers, which comprise about 85% numerically of the consumers of western utilities, are the ones increased mostly when rates are changed from prevailing ones to those that cause each consumer to pay for the consumer expenses created by him. Any attempt to introduce a more equitable form of rate is vigorously opposed by city councils because it will raise the cost of service to a large number of consumers, and they fear that would mean a loss of votes. We, therefore, have the peculiar condition of a large number of people using the power of the ballot to compel a few to contribute to the living expenses of the many.

Range of Consumer Expense Not Large

It has been stated before that the differential in costs between different towns and large cities is small. The difference in the consumer expenses between the largest city in Iowa and the average town will be found to be about 30 cents. Towns will be found to have a cost of approximately $1.10. Now assume that by some legerdemain electricity can be produced for nothing by water power, oil engine, or super-power plants, that is in so far as the energy expenses are concerned, the consumer expenses would not be affected and the consumer expense for a con-

sumer using kilowatt hour per month would still be $1.10, for one using 10 K. W. H. per month would be 11c per K. W. H., and for one using 20 K. W. H. per month, which is about the average use of the average residence consumer, would be 5.5c per K. W. H.

Capacity Expenses

The capacity expenses are more difficult to take care of in rates, that is, to do so in an equitable manner. If they are introduced as a flat kilowatt hour charge then all those consumers who used the equipment longer hours than the average pay more than they should and those who use the equipment shorter hours than the average pay less than they should. If the capacity expenses are introduced as a flat demand charge found by dividing the expenses by the sum of the demands of all the consumers then those consumers who use the equipment longer hours than the average pay too little for the service and those who use the equipment shorter hours than the average pay too much. These statements are made clear by the following examples:

(1) Assume a 100% load factor consumer with a demand of one kilowatt. He should pay for the capacity expenses an amount found by dividing the total capacity expenses by the maximum load on the system. This, say, is $7 for one K. W. demand. Assume the capacity expenses divided by the number of kilowatt hours is 3.7 cents per Kwh, then the kilowatt hours used per average month by a 100% load factor consumer would be 730 and the cost at 3.7c would be $27.28, or $20.28 more than the cost of the service.

(2) Assume that the same expenses divided by the sum of the demands is $1.88. It will be seen in this case that the 100% load factor consumer is served for $5.12 less than cost. All the above values are consistent with actual practice.

From the above it is evident that by some combination of these two methods wherein part of the capacity expenses are made to function with kilowatt hours and the balance with the maximum demands of the consumers an accurate and equitable method would be had for introducing the capacity expenses into rates. The proper combination and values can be obtained readily from two simple equations in which:

X=The unit Kva demand costs of that portion of the total capacity expenses that can be made to function with the Kwh supplied the system, or the consumers of a system.

Y=The unit Kva demand costs of that portion of the total capacity expenses that can be made to function with the Kva maximum demand of systems, or of consumers of a system.

D=The sum of the maximum demands taken regardless of the time of day of the system, or of the consumers of a system.

P=The Maximum Demand of all systems on their sources of supply taken during a half hour of any predetermined interval, or the Maximum Demand of consumers of a system.

K=The Kilowatt Hocrs used by all the systems, or the kilowatt hours used by all the consumers of a system.

C=The total Capacity Expenses of all the systems, or the total Capacity Expenses of all the Consumers of a system.

730=The kilowatt hours in the average month for a one kilowatt of demand at 100% power factor operated at 100% load factor.

The Equations are:

$$Kx + Dy = C$$

$$730x + y = \frac{C}{P}$$

By using the same data from which the $7.00, $1.88, and 3.7+cts were obtained, the value of × is 7.5+ mills instead of the 3.7+ cts., and the value of y is $1.50+ instead of the $1.88. The average kilowatt hours per consumer is $50.3+.

When these demand costs are added to the consumer costs it will be readily seen why short hour consumers cannot have a low cost per Kwh unless the loss that would be sustained on the short hour consumers is shifted to the long hour consumers. Take the residence service, excluding those with ranges which to date form a small per cent, the average demand is about 750 watts, giving a demand charge of about $1.12. Add to this the $1.10 consumer charge, the cost for 1 Kwh is $2.2275; for 10 Kwh, $2.295 or 22.95c per Kwh, and for 20 Kwh $2.375 or 11.87c per Kwh. The cost of fuel, etc., has not yet been included.

To properly apply a demand charge, the demand of a consumer must be determined in some manner, and this de-

termination has objections which are in many cases serious. There are decided objections to the use of demand rates for residence service. The principal ones are:

(1) The difficulty of explaining the rate to the many consumers.

(2) The extra cost of obtaining the demands.

(3) The tendency to curtailment on the part of consumers in the installation of lights and devices.

In so far as residence service is concerned the writers are of the opinion that, owing to the great diversity in use not only of lights but of all kinds of heating devices and small power, and the great similarity in use by the different consumers, the demand portion of the capacity expenses can all be covered in properly arranged kilowatt hour step charges within a degree of accuracy that the greatest error would not exceed the extra cost of applying an accurate demand method.

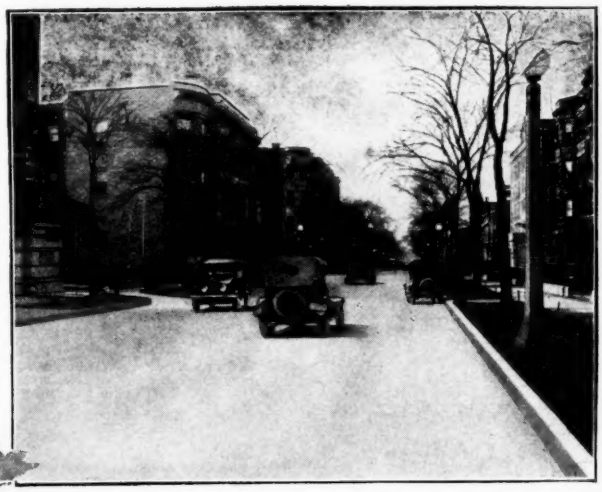
For commercial lighting and power services the demand must be made a direct element of the rate if the rates are to be equitable between consumers. This is because of the great dissimilarity in the number of hours of use. The rate is often difficult of introduction in cities and towns, because many commercial lighting and power consumers have not been educated to the pure demand form of rate. A rate which will approach the pure demand form is therefore generally adopted and such a rate can be made that is reasonably equitable by covering all the demand portion of the capacity expenses in a predetermined number of hours' use of the demand, say, the first 40 hours, and is found by dividing the demand portion of the capacity expenses by the actual number of kilowatt hours included in the first, say, 40 kilowatt hours' use of the demand, or by dividing part of such expenses by the kilowatt hours included in the first, say, 40 hours' use and the balance in the second 40 hours use of the demand. Since a greater degree of equity results when all commercial light and power consumers are placed on a pure demand basis, that ideal should be the ultimate goal.

The energy expense is easily taken care of, and is found by dividing the total energy expenses by the total kilowatt hours used. To this unit energy charge must be added the kilowatt hours portion of the capacity expenses, as found by the value of X in the formula. The sum becomes the electricity rate.

By the time each consumer has been charged with the consumer expenses, the demand portion of the capacity expense, and the kilowatt hour portion of the capacity expense it will be found that the energy costs do not cut much figure for fully 85% of the consumers, they use so little electricity. These consumers, however, are vitally interested in the investment required for production, transmission, and distribution. It is only 15% of the consumers who are vitally interested in cheap production. Any exactions by councils, regulating commissions, or the people which tend to increase investments, not warranted for economical and protective reasons, will have a greater relative effect on the 85% than on the 15%. Water power in Iowa, at the present price of coal, is warranted only as a means of conservation of fuel. A modern steam plant with present fuel costs, but investment costs excluded, can produce electricity at a lower cost per kilowatt hour than can be done by any water power in Iowa, when the water power investment costs are taken as energy costs. The water power plants in Iowa require a steam reserve, therefore, the capacity expenses of the steam plants are substantially the same with as without the water power and the transmission costs are often increased by the installation of water power because of the extra transmission line used exclusively for connecting the water power plant with the general transmission system. The claims of cheap production of electricity by oil engines is often more than offset by the higher cost of investment and maintenance expenses. This is especially true for low load factor operation. Here again, even where the oil engines show a great saving in the cost of production, it is only the 15% of the consumers who have any material interest in the higher economy. It is the 15% who are materially affected by reductions in the unit energy costs, because of the relatively high proportion of energy cost to the consumer and capacity costs, whereas with the 85% the energy cost of each consumer forms a very small portion of the total costs and, in fact, the total cost would not be greatly affected if by some legerdemain the energy costs were reduced to nothing.

The foregoing paper was presented at the recent annual meeting of the Iowa Engineering Society.

Fullerton Parkway, Chicago, Ill. Tarvia-built 1909. Note excellent condition of street after fifteen years of uninterrupted service.



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